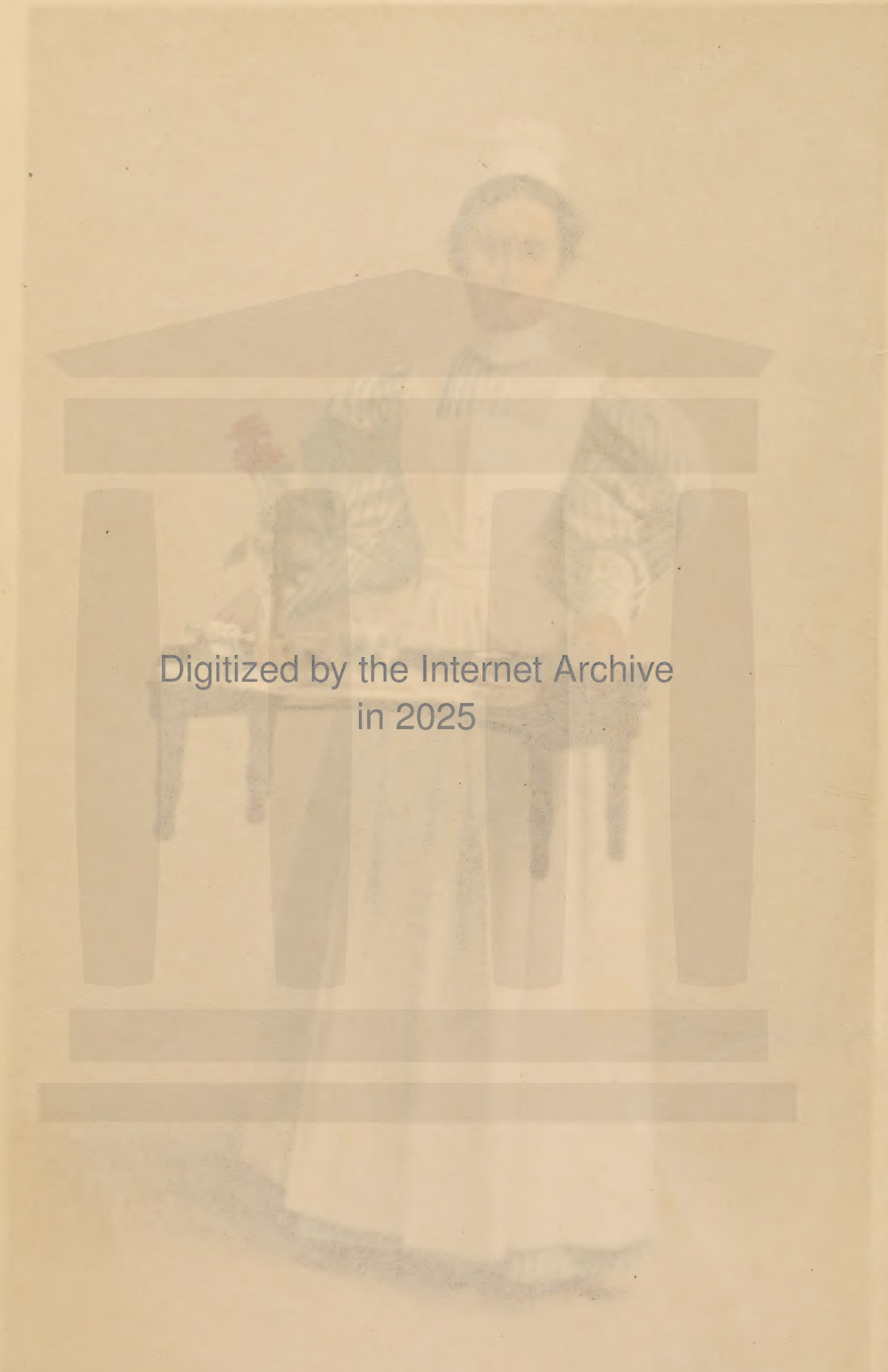
PLATE I



A TRAINED

IN SICKNESS AND IN HEALTH

A MANUAL OF

DOMESTIC MEDICINE AND SURGERY, HYGIENE, DIETETICS, AND NURSING,

DEALING IN A PRACTICAL WAY WITH THE PROBLEMS RELATING TO THE MAINTENANCE OF HEALTH, THE PREVENTION AND TREATMENT OF DISEASE, AND THE MOST EFFECTIVE AID IN EMERGENCIES

BY

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PUBLISHERS' NOTE.

In response to what appeared to be a general demand, the publishers have prepared a book for household use that, while popular and attractive, embodies in a thoroughly practical form the latest and most complete information in regard to domestic science and kindred topics, including medicine and surgery, hygiene, dietetics, and nursing.

Knowledge of the laws governing health and disease, how to promote the former and how to avoid the latter, as well as what to do and what not to do in emergencies, has hitherto been hidden away for the most part in text-books and special treatises to which the unprofessional man and woman had no access, or, if accessible, the information was so shrouded in technical language as to puzzle and disconcert the reader.

It is hoped that this work, which combines scientific with literary excellence, will meet the requirements of the intelligent reading public. The aim throughout has been to give absolutely correct information in clear and simple language.

In order that the various topics might be treated by those qualified to write with authority, the publishers secured the services of an able corps of specialists, each eminent in his own domain, who worked under the direction of experienced editors.

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The Anatomy of the Human Body.

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THE ANATOMY OF THE HUMAN BODY.

BY GEORGE WALDO CRARY, M. D.

INTRODUCTION.

HUMAN anatomy is the science which treats of the *structure* of the human body. In the study of it we learn the identity and characteristic features of the various organs composing the body, and their location in relation to one another. Anatomy has but little to do with the functions of these organs, and hence can be studied upon the dead body with the aid of dissection. By dissection is meant the exposing of a structure by cutting away from it all other organs which by their presence obscure it from our view.

SECTION I.

THE BONES.

The scaffolding or skeleton upon which the body is constructed is composed of bones and bears much the same relation to the whole as do the steel columns and beams to the modern building. These bones are joined together in a variety of ways; in some cases very firmly, for strength, in others loosely, for motion.

Bone is the hardest structure entering into the formation of the body, and is composed of two kinds of tissue. One of these is soft and light, and is composed of slender fibres which are interlaced and have between them spaces of considerable size. This, called the cancellous tissue, always occupies the inner portion of the bone and contributes much to its strength, while adding but little to its weight. The outer portion is hard and dense, like ivory, and is heavy, the fibres being very closely interlaced and the spaces exceedingly small. This outer compact layer is very thin in the flat bones, such as make up the vault of the head; is thick along the middle of the long bones, as in

Structure of Bone.

the extremities; but again thin near their ends. This latter condition is well shown in the accompanying illustration (Fig. 2) of a long bone sawed through lengthwise, where it can be seen that the fibres are arranged ac-

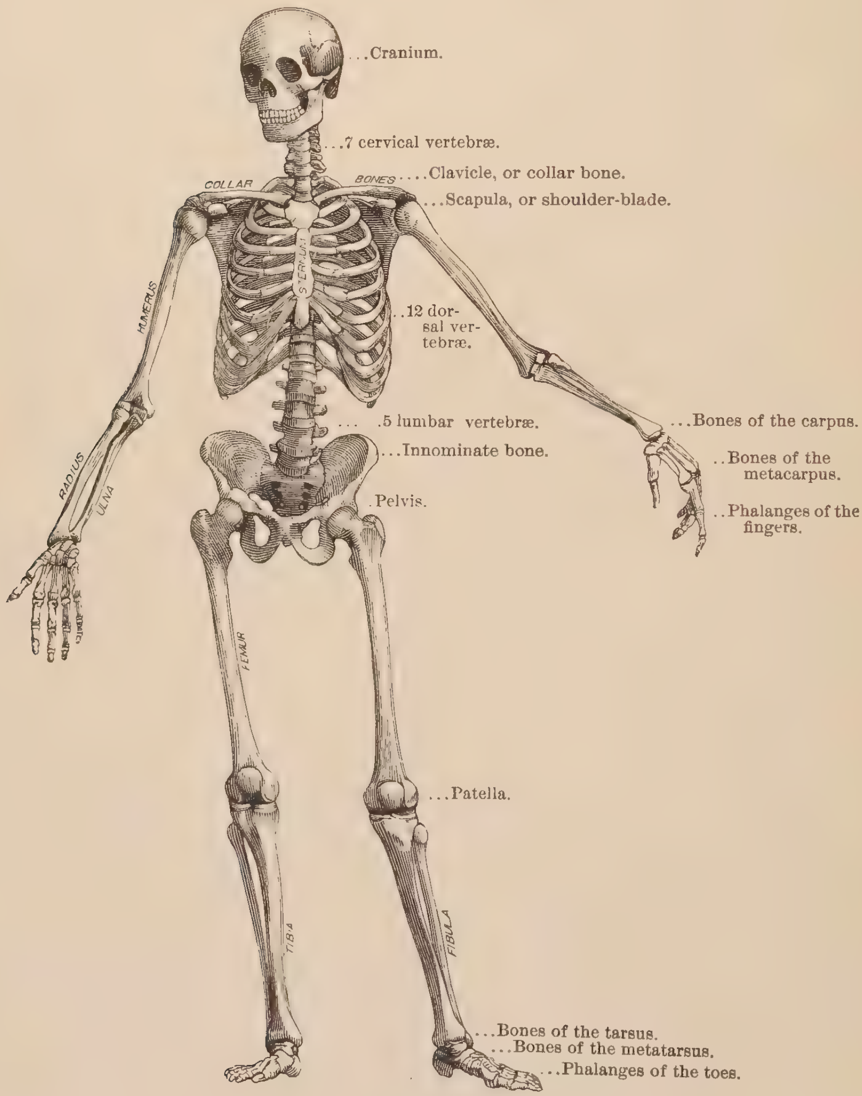

Fig. 1.—The skeleton.

cording to the best mechanical laws for enabling the bone to perform its function of supporting weight.

During life the bones are closely covered by a somewhat thick and tough membranous envelope called the periosteum, which protects the bone, and

from which blood-vessels pass to the outer compact tissue of the bone, and thus to it is carried the nourishing blood-supply. The inner, softer tissue receives nourishment from vessels which reach it after perforating the outer layer. The long bones are hollow cylinders the cavities of which contain marrow—a yellow substance composed almost entirely of fat. In the interior of the flat bones is another kind of marrow which is red and contains only a trace of fat and which consists mostly of water, with a little albumen and some other substances.

Chemical Composition.

Chemically, bone consists, in the healthy adult, of one third animal matter and two thirds mineral matter, so intimately combined that either one may be removed without the shape or size of the bone being altered. The mineral matter gives to the bone its hardness and rigidity, while the toughness and elasticity are contributed by the animal matter. For example, if we soak a long bone in dilute mineral acid so as to dissolve out the mineral matter, though its appearance will be little changed, it will become soft and pliable and can even be tied into a knot, as the illustration shows (Fig. 3). If we put a long bone in the fire and destroy the animal matter contained in it, we shall find that we have left a bone somewhat less heavy, but which will break and crumble unless very carefully handled. The bones of young children contain more animal than mineral matter, and frequently a fall which would result in broken bones in the adult causes no harm at all, or only a bending of a bone, in a child. Such a bending or partial break of a bone is known as a "green-stick" fracture. In some diseases, such as rickets, this preponderance of animal matter is so great that the bones are weakened and become curved and bent by the weight of the body or by the action of muscles. At a very early period of life, and some months before birth, the bones are composed entirely of animal matter. Then, at one or more points in each bone the mineral substance begins to be deposited, and from these points the deposits gradually extend until at length the whole bone becomes what is called "ossified." This process is very incomplete at birth and is not finished until about the twenty-fifth year. In the aged, and in certain diseases, the proportion of mineral matter increases beyond the normal two thirds, and the bones become brittle and are easily broken by sudden movements or by slight violence.

FIG. 2.—THE RIGHT FEMUR, OR THIGH-BONE, SAWN IN TWO LENGTHWISE, SHOWING ARRANGEMENT OF COMPACT AND CANCELLOUS TISSUE.

There are two hundred bones in the human body, and when joined together they form the skeleton. These bones are distributed thus:

Spinal column	26
Skull	22
Hyoid bone, breast bone, and ribs	26
Upper extremities	64
Lower extremities	62
	200

Shape and Arrangement.

The bones vary widely in size, shape, and position, according to their use, but are largely arranged in pairs, so that of these two hundred bones there are one hundred and sixty-six in pairs; and of the thirty-four single bones, all are in the median plane of the body and have a right and a left half of similar shape. According to their shape, bones are said to be long, short, flat, or irregular. Long bones, as the bone of the arm or of the thigh, are composed of a middle long portion called the "shaft" and two ends called "extremities." The short bones are such as are found in the wrist. The flat bones are found where broad surfaces are required for protection or for muscular attachment. Flat bones are bones the length and breadth of which greatly exceed their thickness—the shoulder-blade, for example. The bones of the vault of the skull are of this variety. Bones which are not long, short, or flat are classified as irregular, and some of the bones of the skull—such as the cheek bones, the lower jaw, etc.—come under this heading.

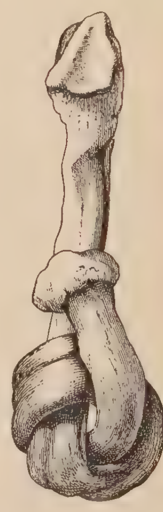

Fig. 3.—Fibula tied in a knot, after maceration in a dilute acid. From a specimen preserved in spirit. (Dalton.)

The Spine.

The spinal column or backbone is composed, in the adult, of twenty-six irregular bones, called vertebræ, placed one above another. It is divided into well-marked regions—the neck or cervical region, containing seven vertebræ; the dorsal or chest region, containing twelve; and the lumbar or loin region, containing five; below this comes the sacrum, formed by the fusion of five vertebræ which are distinct in early life; and still lower down the coccyx, composed of the fusion of four partly developed vertebræ. While a vertebra from one end of the spine differs much from one taken from the other end, two contiguous vertebræ differ only slightly. Each vertebra is composed of a solid front portion or body and a branched back portion, which latter encloses a ring (Fig. 4). If we remove from about the middle of the spine a vertebra and study it, we shall see that the solid portion or body has an upper and

lower surface, which is flat and rough, for the attachment of the intervertebral substances which connect it to the vertebræ above and below it.

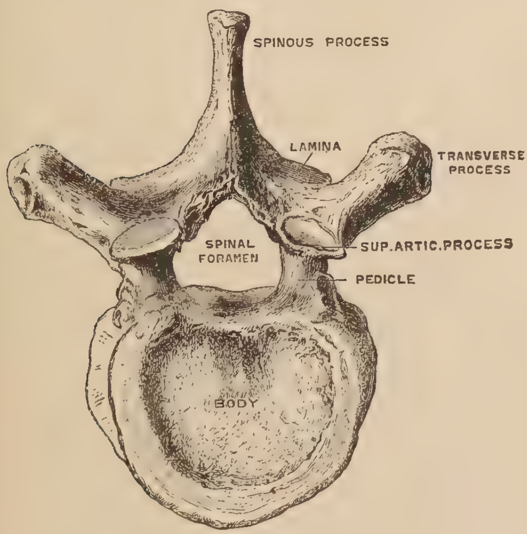

Fig. 4.—Sixth dorsal vertebra, from above. (Quain.)

In front it is rounded, and behind slightly hollowed out where it assists in forming the spinal canal. Projecting backward from each side of the body, and nearer its upper than its lower surface, we see a process of bone which forms the beginning of the arched portion. These are called the pedicles. The arch is completed by two plates called the laminæ, which spring, one from each pedicle, and join in the median line behind. At this point of junction of the two laminæ behind there is another process of bone known as the spine of the vertebra, and it is the ends of these processes which we can feel as we pass our finger down the middle of some one's back. There are six other processes of bone springing from this branched portion—four for articulation with other vertebræ and two for muscular attachment.

Curves of the Spine.

The solid portions, taken together with the intervertebral substance, or cushions of dense fibrous material between them, form a strong column which supports the great bony cavities of the body. The back and branched portions form a series of arches called the spinal canal, for the passage of the spinal cord, which is thus strongly protected. Besides supporting weight and protecting the cord, the spinal column gives numerous places of attachment to muscles which move the body itself and the extremities. When we look at the spinal column from the side we see that it is curved in four places. These curves are for the purpose of giving greater elasticity to the column, thereby enabling it to bear greater shocks, and without so much disturbance to the structures supported by it.

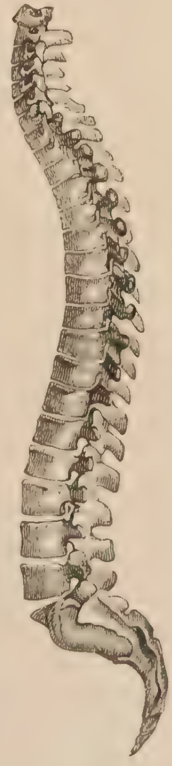

Fig. 5.—The spine, lateral aspect.

They are formed by the shape, partly, of the bodies of the vertebræ, and partly of the intervertebral substances, and are so arranged as to increase the capacity of the two great bony cavities partially formed by the spine —namely, the chest and pelvis. In the cervical, or neck, and in the lumbar or loin regions, the convexity is forward, while in the dorsal, or chest, and in the pelvic regions formed by the sacrum and coccyx, the concavity is forward.

Intervertebral Substance.

The disks of intervertebral substance existing between the bodies of the vertebræ are tough and elastic and, while forming strong bonds of union between the vertebræ, act as cushions and allow some movement to take place. This movement is small between any two vertebræ, but in the spine, as a whole, is rather extensive. During the day the body is said to lose in height and to regain it again during repose in a horizontal position. This loss is due partly to some flattening of each intervertebral disk and partly to the increase in the normal curves of the spine. The aged lose in height from the same and other causes. In that condition of the spine known as Pott's disease (or spinal disease) the bodies of one or more vertebræ are so softened that the weight of that portion of the body above them causes them to collapse, and then the normal curve is enormously increased and the body much shortened in consequence. Such a course of events results in the condition known as *hump back*. (See *Surgical Injuries and Surgical Diseases*.)

THE SKULL.

The Head or Cranium.

Of the twenty-two bones of the skull, eight go to make up the head or cranium, which is the bony box in which the brain is lodged and protected from injury. In the adult this is closed, with the exception of one large opening for the passage of the spinal cord, and numerous small openings for the transmission of nerves and blood-vessels; but in the infant, owing to the fact that ossification is not complete, there is left on top, toward the forehead, a large, diamond-shaped opening, "the soft spot" (through which the pulsations of the arteries of the brain may be felt), and five other small openings, two upon each side and one near the back of the head. (See Fig. 7.) This slow ossification of the bones of the head allows for the growth of the brain; a child born without any of these openings is apt to be idiotic, have convulsions, and may even die.

A full and detailed description of the individual bones of the head cannot be given in a work of this kind, and nothing beyond an enumeration of them and their most striking peculiarities and position will be attempted. The eight bones are: One occipital, two parietal, one frontal, two temporal, one sphenoid, and one ethmoid. The occipital, shaped

something like a butter scoop, such as is used in a dairy, with a hole in the bowl and a broken handle, occupies the back of the head. This large hole, the foramen magnum, is nearer the front than the back and corresponds to the spinal canal in the vertebral column, and transmits the spinal cord and a few nerves and arteries. Upon each side of this foramen, but near its front border, is a kidney-shaped, smooth surface, which articulates with similar surfaces upon the sides of the first cervical vertebræ. There are two parietal bones—a right and left. They are of a curved quadrilateral shape and form most of the roof and a great por-

Occipital, Parietal, Frontal, Temporal, Sphenoid, and Ethmoid Bones.

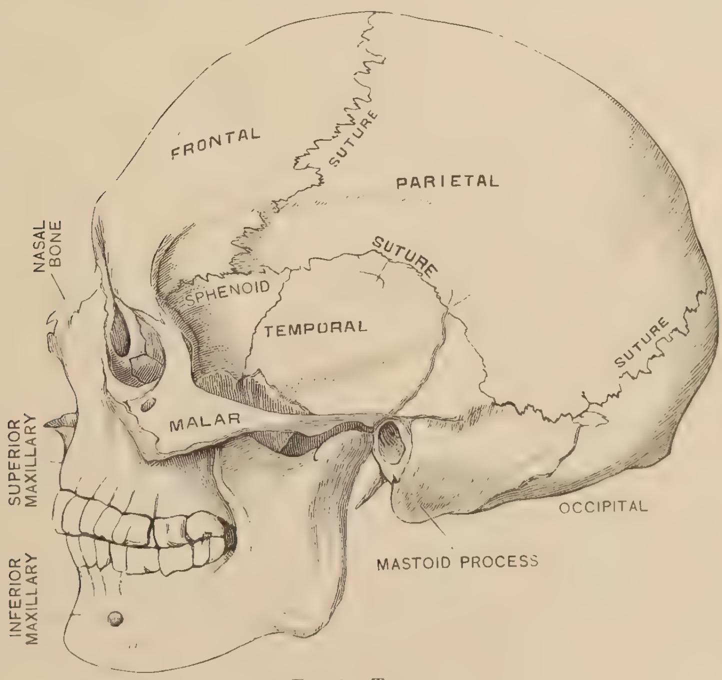

Fig. 6.—The skull.

tion of the sides of the cranium. The frontal bone much resembles a cockle shell in form and consists of two portions which join at nearly a right angle. The vertical or frontal portion forms the forehead and the front wall of the cranial box. The horizontal portion extends backward, forming the roofs of the cavities for the eyes, known as the orbits, and also a part of the roof of the nasal cavity. In the young the bone is divided into two lateral halves, and even in late adult life the remains of this division may be seen. The temporal bone is divided for description into three portions: One, a thin plate of bone, assists in forming the side of the cranium; another, the mastoid, forms the prominence which can be felt back

of the ear, and is hollowed out in its interior by a number of cavities which have a connection with the middle ear, and in active cases of neglected ear disease become seriously involved in the inflammation; the third portion of the temporal bone is of an irregular conical shape and assists in forming the base of the skull, and contains within it the organ of hearing and the canal leading from the middle ear to the outer world. The sphenoid bone, the most irregular bone in the head, is shaped something like a bat with its wings spread. The central portion or body enters into the formation of the base of the skull. The outer surfaces of the great wings, upon each side of the skull, appear upon the outer surface of the cranium at about the point ordinarily called the "temple." The inner surface of these wings forms the back part of the outer walls of the orbits. This bone is wedged into the base of the skull and has many processes which serve to connect it with many of the other bones both of the head and face. The ethmoid bone is a light, spongy bone situated at the front part of the base of the skull, between the orbits, and forms the greater part of the inner walls of these cavities. It also forms part of the septum, or dividing partition between the two nasal cavities, as well as a portion of their roof.

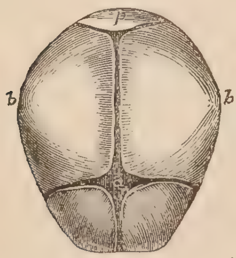

FIG. 7.—SKULL OF A CHILD AT BIRTH, FROM ABOVE. (Leishman.) ONE THIRD. a, anterior fontanelle; p, posterior fontanelle; b, b, parietal eminences. (Quain.)

Bones of the Face.

The bones of the face are: Two nasal, two superior maxillary, two lachrymal, two malar, two palate bones, two inferior turbinated, one vomer, and one inferior maxillary bone. The nasal bones form together the "bridge" of the nose. The superior maxillary is the upper jaw. It forms almost all of the floor of the orbit, the greater part of the outer walls of the nasal fossa, and the major part of the roof of the mouth. Into it are inserted the upper teeth. The palate bones join on to the back of the superior maxillæ and complete the floor of the orbits, the outer walls of the nasal cavities or fossæ, and the roof of the mouth, but are too far back to have any of the teeth inserted into them. The lachrymal bones are small and fragile, about the size of a finger-nail, and are placed upon the inner walls of the orbits very near the front. The malar bones form the prominence of the cheek, and in the thin and emaciated are especially noticeable. The turbinated bones are situated one upon the outer wall of each nasal fossa, and are frequently nowadays the subjects of operation by specialists because of undue enlargement. The vomer is a thin plate of bone which assists the ethmoid in separating the two nasal cavities one from the other. The inferior maxillary, or lower jaw, is of irregular horseshoe shape, with the ends bent upward at almost a right angle. These ends

are surmounted by two prominences. The one in front is pointed, and gives attachment to the strong temporal muscle which closes the jaw. The one behind is of somewhat rounded shape at the top, and is called the condyle. It is constricted below where it joins the bone, and this constricted portion is called the *neck* of the condyle. This is the one bone of the skull which is movable, and it articulates, by means of this condyle, with a shallow cavity upon the under surface of the temporal bone just in front of the ear. Into the lower jaw are set the lower teeth. The jawbone in the young is composed of a right and left piece which meet at the chin. It will thus be seen that of the fourteen bones of the face there are twelve occurring in six pairs, and only two which are single bones—viz., the vomer and the inferior maxillary.

THE RIBS.

There are twenty-four ribs, twelve upon each side of the chest. All are connected behind with the dorsal vertebræ of the spine in such a way

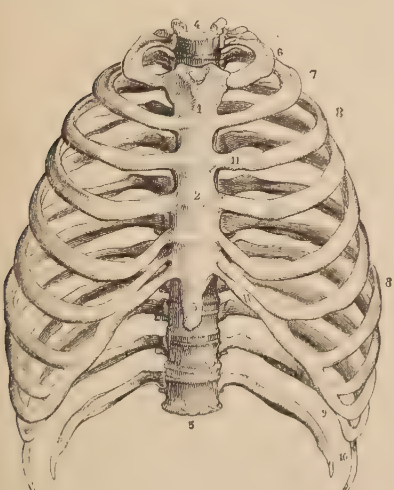

FIG. 8.—THORAX, ANTERIOR VIEW. (Sappey.) 1, 2, 3, sternum; 4, circumference of the upper portion of the thorax; 5, circumference of the base of the thorax; 6, first rib; 7, second rib; 8, third rib; 9, 10, floating ribs; 11, costal cartilages.

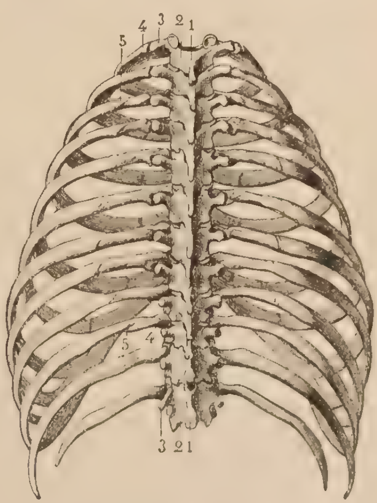

FIG. 9.—THORAX, POSTERIOR VIEW. (Sappey.) 1, 1, spinous processes of the dorsal vertebræ; 2, 2, laminæ of the vertebræ; 3, 3, transverse processes; 4, 4, dorsal portions of the ribs; 5, 5, angles of the ribs.

as to allow considerable motion. The upper seven are connected in front with the breast bone or sternum, and are called true ribs. Of the remaining five or false ribs the upper three are too short to reach the sternum, and each one is connected in front with the rib just above it; the two lower ribs are not attached to anything in front, being very short, and are called floating ribs. The ribs are arranged one below another in such a manner

that spaces are left between them called "intercostal spaces." The ribs are not composed entirely of bone, for their front extremities are formed of cartilage, which arrangement adds elasticity to the chest wall. This cartilage is a substance softer than bone, but of firm consistence and considerable elasticity, and is of a pearly white colour. Besides forming the front ends of the ribs, cartilage covers the articular ends of the bones, and forms the framework of the outer ear and most of the nose.

THE UPPER EXTREMITY.

The upper extremity consists of the arm, forearm, and hand, and is connected with the body at the shoulder. The bones of the shoulder are two in number—the collar bone or clavicle and the shoulder-blade or scapula. The collar bone is shaped something like the Italic letter *f*. It is nearly horizontal, and by its inner end joins the breast bone near the top, forming here a movable joint. *This joint is the only bony connection the upper extremity has with the body.* The outer end of the clavicle is attached to that portion of the shoulder-blade which arches up to meet

Clavicle and Scapula.

Fig. 10.—Upper surface of left clavicle, or collar bone.

it. The shoulder-blade or scapula, a large flat bone of somewhat triangular shape, forms the back of the shoulder, and is held in position most largely by muscles. From the back of this bone a large process or plate of bone arches upward and forward, forming what is known as the spine of the scapula. The end of this process of bone or "spine" forms the summit or "point" of the shoulder, and joins with the outer end of the clavicle, as mentioned above. The upper and outer angle of the scapula is thick, and is called the head of the bone. It is occupied by a shallow cup for the reception of the head of the bone of the arm which joins it at this place. This cup itself is very shallow, but the spine already mentioned, and another smaller process of bone called the coracoid process, which springs from the scapula just above its head, make it practically deeper than it appears. These processes of the scapula arch over the cup for the head of the bone of the arm, and render the joint more secure.

In the arm proper or upper arm there is only one bone, the humerus. It is the longest and largest bone of the upper extremity, and its shape is

somewhat suggestive of a dumb-bell with small ends and a long handle. Only the upper end, however, is distinctly globular, and this globular end, called the head of the humerus, represents one third of a sphere, and fits into the shallow cup or socket in the head of the shoulder-blade. At this upper end we have also two rough prominences or tuberosities for the attachment of muscles, and

Humerus.

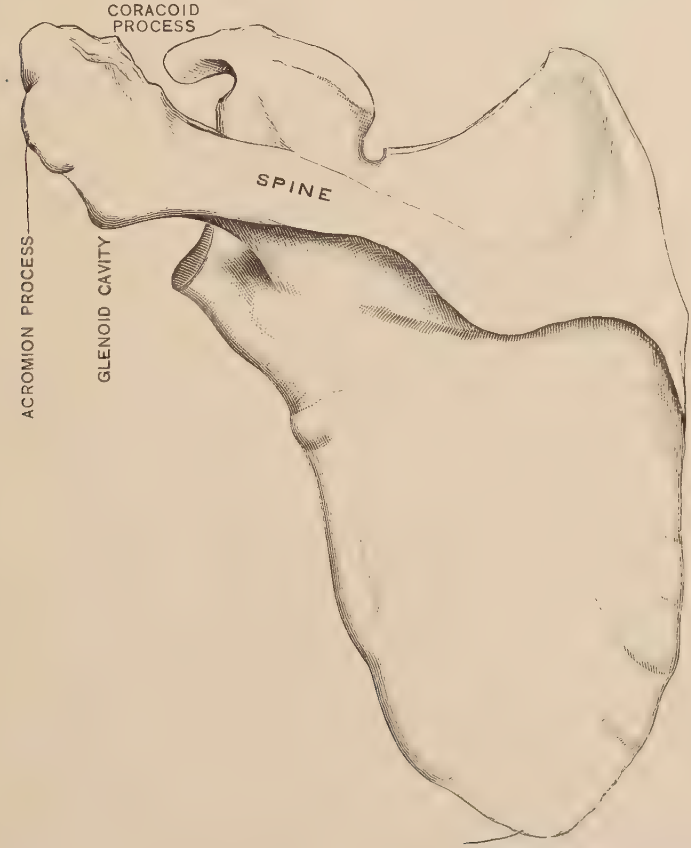

Fig. 11.—Left scapula, or shoulder-blade.

between them a groove for the passage of one of the tendons of the biceps muscle. Just below these tuberosities the shaft of the bone is somewhat constricted, and it is here that fracture or break of the bone most frequently occurs. This is called, therefore, the surgical neck of the humerus. The lower extremity of this bone is somewhat flattened from before backward, and thus appears wider when looked at from in front or behind than from the side. The lower extremity has a rough knob of bone upon either side for muscular attachment. Along the mid-

dle of this lower end of the humerus are two smooth surfaces, one of which, the radial head, is round and situated toward the outer side. This surface has articulating with it the upper end of the outer bone of the

Fig. 12.—Left humerus.

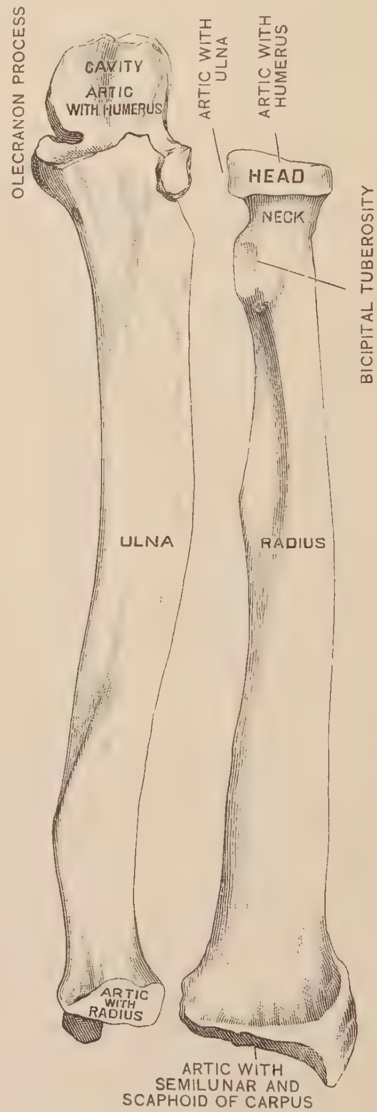

Fig. 13.—Left radius and ulna, or bones of the forearm.

forearm. The other of the two smooth surfaces, the trochlea, is on the inner side, and is curved for articulation with the inner bone of the forearm.

The inner bone of the forearm is called the ulna. Its upper extremity is large while its lower extremity is small. In most long bones the smooth surfaces by which they join or articulate with other bones are at the extreme ends, but in the upper extremity of the ulna the smooth surface for articulation with the humerus is hollowed out of the front portion at a little distance from the end. The lower extremity of the ulna is small and somewhat pointed.

Ulna and Radius.

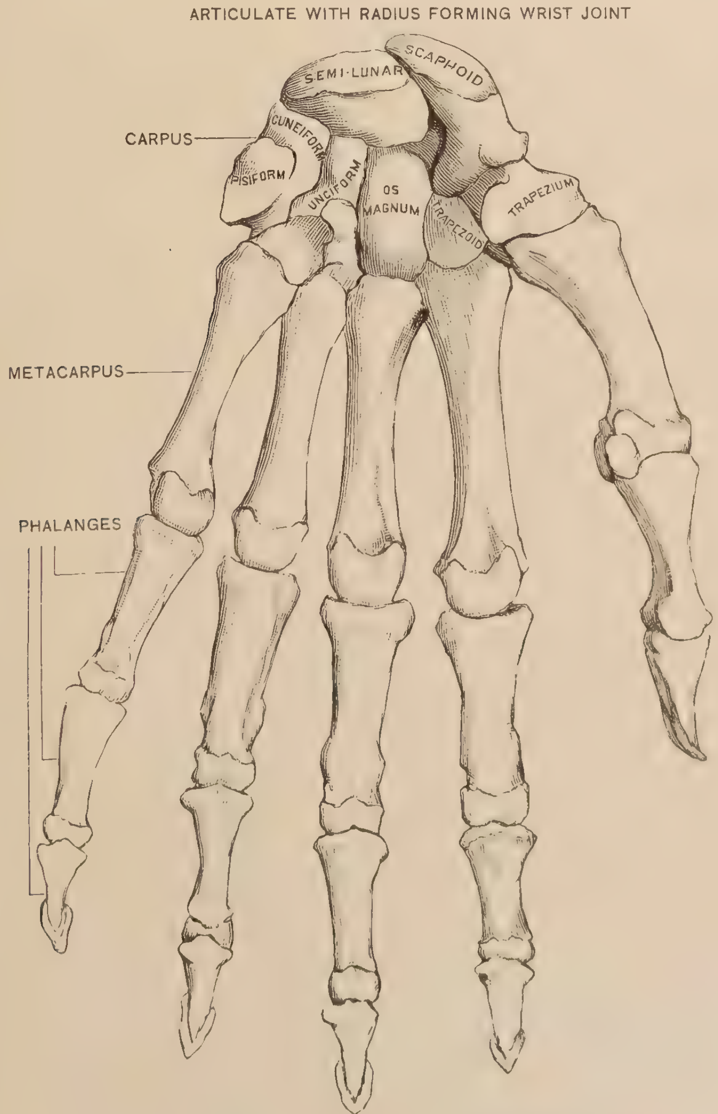

Fig. 14.—Bones of the left hand; palmar surface.

The outer bone of the forearm is the radius. In this bone the upper end is small while the lower end is very large and broad, and to it the wrist and hand are joined. This bone is the one that supports nearly all the pressure brought to bear upon the hand, and hence is frequently broken by falling upon the hands. (See Fig. 26, *Surgical Injuries and Surgical Diseases.*)

The Hand.

The wrist is composed of eight cube-shaped bones arranged in two rows. The first row joins above with the lower extremity of the radius, and below with the second row; the second row joins above with the first row, and below with the metacarpal bones. These latter are five rather long bones arranged nearly parallel to each other. They are very similar in shape to the bones forming the fingers, but are connected together in such a way as to form a more or less solid portion of the hand. The first one of these bones makes an angle with the rest, and to it the thumb is attached. This bone is so joined to the wrist bones that in closing the hand it can be carried over in front of the other fingers, and when the hand is only partially closed it can be approximated to any of the other fingers. The power and perfection of the human hand, and its superiority over the prehensile members of all other animals, result from this unique ability of the thumb to approximate itself to the other fingers of the hand. To the second bone of the hand proper the index finger is attached, to the third the middle finger, to the fourth the ring finger, and to the fifth the little finger. In the fingers there are fourteen bones, three for each finger and two for the thumb. The end bone of each set is differently shaped from the other two, and supports the pulp of the finger tips.

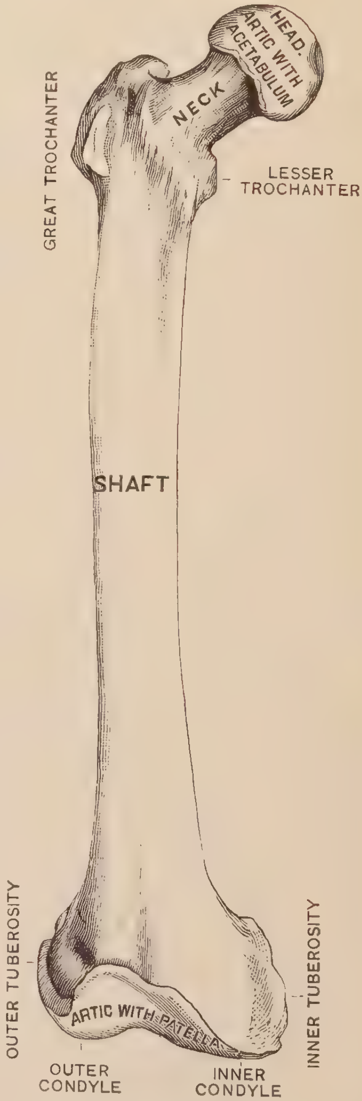

Fig. 15.—Right femur, or thigh bone.

THE LOWER EXTREMITY.

The lower extremity consists of the thigh, the leg, and the foot, and is connected to the body on each side by means of the hip bone. These two irregular hip bones, one on each side of the body, were called by the old anatomists the innominate, or nameless bones, because they bore no resemblance to any known object. In the young, each innominate bone consists of three portions joined together near the centre, and here forming a cup-shaped cavity or socket for the reception of the head of the thigh bone. Of these three portions, the upper forms the prominence of the hip. Of the two remaining, one is behind and forms the prominence upon which the body rests in sitting, while the other joins in front of the body with the similar portion of the opposite bone, and thus forms what is known as the pubes, so called because in the adult it is covered with hair. Each innominate bone is joined behind to the sacrum, and thus a somewhat incomplete bony basin or cavity called the pelvis is formed, which contains the lower portions of the bowels, the bladder, and, in the female, the vagina, the uterus, and the ovaries.

Hip.

The thigh bone, or femur, extends from the hip to the knee, and is the longest, the largest, and the strongest bone in the body. At its upper end we find a smooth rounded head which forms three quarters of a sphere. This head is connected to the shaft of the femur by means of the neck at an obtuse angle of about a hundred and thirty degrees. At the junction of the neck and the shaft we have two large processes of bone, called the tuberosities, for muscular attachment. The shaft of the bone in the greater portion of its extent is nearly cylindrical in shape. At the lower end of the shaft we find that the bone is much enlarged for articulation with the large bone of the leg, here forming the knee joint. The knee cap, or patella, is a small, smooth, rounded bone which protects the front of the knee joint from injury and assists the large muscles of the thigh that pass in front of the joint to act upon the leg, as in kicking or walking.

Femur.

FIG. 16.—THE PATELLA, OR KNEE CAP.

In the leg there are two bones, though one, the fibula, is slender and adds but little to the strength of the leg, serving mostly as a place of attachment for some of the muscles that move the foot. It is placed on the outer side of the leg and extends downward to form the outer ankle. The larger of the two bones of the leg—viz., the tibia—is situated on the inner side of the leg and somewhat

Leg.

in front of the fibula. It has a broad upper end for articulation with the femur and a smaller lower end for articulation with the foot. This lower end is continued downward somewhat below the joint, and forms the

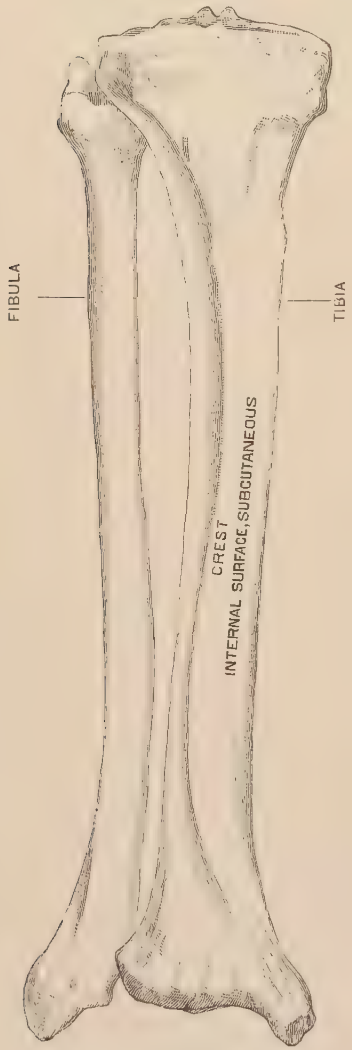

Fig. 17.—Right tibia, or shin bone, and fibula or splint bone; anterior surface.

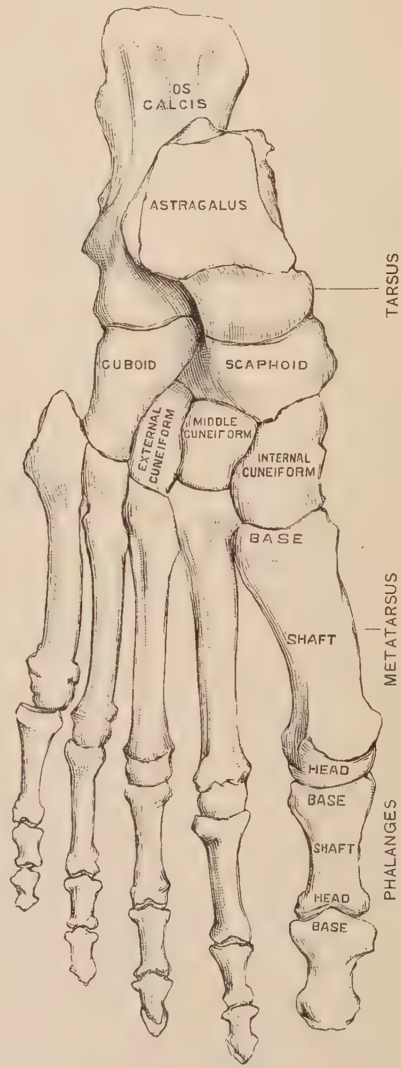

Fig. 18.—Bones of right foot: dorsal surface.

inner ankle. The shaft of the bone is triangular upon cross section, with its sharp edge in front, commonly known as the shin.

Foot. The foot is formed of twenty-six bones. Seven of these are nearly cuboid in shape, and are clustered together

somewhat after the fashion of the bones of the wrist. The rest of the foot is similar to the hand, with the important exception that the great toe cannot be "approximated" to the others, as is the case with the thumb in the hand. The bones of the toes, also, are shorter than the bones of the fingers.

SECTION II.

THE JOINTS.

Varieties of Joints.

The various bones of the skeleton are united by what are called joints, or articulations. When no motion between the bones is required, as in the head, they are brought into close contact and dovetailed into one another in what are called sutures. Such a joint is known as an immovable joint. Where great motion is required, as in the shoulder joint, for example, the ends of the bones are covered by a smooth layer of cartilage. This elastic substance renders the motion between the bones smooth and easy, and protects the ends of the bones from injury. In such a joint the bones are held together in their proper relation to one another, and their motion is limited by numerous bundles of white shining fibres called ligaments. These ligaments usually surround the joint completely, thus forming what is called the capsular ligament, or capsule, and they are especially strong where the greater strain is to be resisted. The ligaments are tough and inextensile, but they are very pliable, thus allowing movement to take place freely, but within limits sharply controlled by their length or position. The internal surface of the capsule or of any ligament in close relation to a joint is lined by a smooth and delicate membrane called the synovial membrane, which secretes a viscid fluid of the consistence of the white of egg. This fluid is the lubricant of the joints, and is called synovia, or synovial fluid. Such a joint as this just described is designated as a movable joint. A joint which is not freely movable, but which allows slight motion to take place, as between the bones of the spine, is spoken of as a mixed articulation. Of the movable there are two principal varieties. One of these is the "ball-and-socket" joint, formed by the reception of a globular head into a cup-shaped cavity, and capable of motion in all directions. The hip and shoulder joints are examples of this variety. (See Fig. 20.) The other variety of movable joints is the "hinge" joint, and in this motion takes place only in two directions—viz., forward and backward. As examples of the hinge joint we have the elbow, the knee, and the ankle. (See Fig. 19.) Joints are further strengthened by the muscles and tendons which surround and pass over them. In order to bring out

more vividly the structure of joints, we will look more minutely into certain of them and study something of their detail. Let us take first the articulation of the inferior maxilla with the temporal bone.

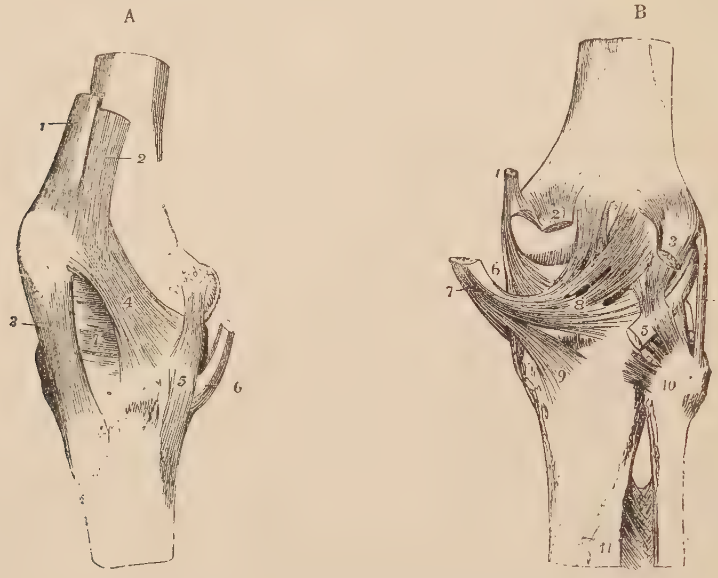

Fig. 19, A.—Right knee joint, from the inner side and anteriorly. (Quain.)

1, tendon of the rectus muscle near its insertion into the patella; 2, insertion of the vastus internus into the rectus tendon and side of the patella; 3, ligamentum patellæ descending to the tubercle of the tibia; 4, capsular fibres forming a lateral ligament of the patella prolonged in part from the insertion of the vastus internus downward toward the inner tuberosity of the tibia; 5, internal lateral ligament; 6, tendon of the semimembranosus muscle.

Fig. 19, B.—Right knee joint, from behind. (Quain.)

1, insertion of the tendon of the adductor magnus; 2, origin of the inner head of the gastrocnemius muscle; 3, outer head of the same; 4, external lateral ligament; 5, tendon of the popliteus muscle; 6, part of internal lateral ligament; 7, tendon of the semimembranosus muscle; 8, posterior ligament, spreading outward from the tendon; 9, expansion of the popliteal fascia downward from the same, represented as cut short; 10, on the head of the fibula, marks the posterior superior tibio-fibular ligament; 11, upper part of the interosseous membrane with the foramen at the upper end for the anterior tibial vessels.

Jaw.

On account of its peculiar shape, the jaw has two articulations, a right and a left, but as they are alike on both sides, it will be necessary to describe only one. There is a smooth rounded process of bone upon the upper and back part of the inferior maxillary, or jawbone, which is called the condyle. This condyle fits into a shallow cavity upon the under surface of the temporal bone, and the surfaces both of the condyle of the jaw and of the shallow cavity of the temporal are covered by a layer of smooth cartilage. The articulation of the jaw is different from most of the joints of the body, in that the bones entering into it do not come into mutual contact. There is a disk lying horizontally between them made up of firm elastic tissue, so that the condyle of the jaw articulates with its under surface, while the

upper surface articulates with the cavity of the temporal. The cavity of the joint is thus completely divided into two compartments. The whole joint is surrounded by a thin layer of ligamentous fibres which are attached above to the margins of the cavity of the temporal, and below to the constricted portion, or neck, of the condyle. This is the capsular ligament, and to its internal surface the disk of elastic tissue referred to above is attached at its circumference. Upon the outer side of this articulation is the external lateral ligament, a short but strong band of fibres, passing from the temporal bone downward to the jaw, and closely connected to the capsule. The interior surfaces of the capsule and of the external lateral ligament, and the upper and lower surfaces of the fibrous disk, are lined by synovial membrane. Upon the inner side of the joint is the internal lateral ligament, longer than the external lateral. This internal lateral ligament is not in close relation to the joint, being separated from the capsular ligament by a considerable interval. This articulation allows of considerable motion, which takes place in three directions, as shown in the (1) opening of the jaw, (2) throwing the chin forward and drawing it back, and (3) moving the jaw from side to side. In wide yawning sometimes the condyle of the jaw is carried forward out of the cavity of the temporal bone and becomes caught so that its return is prevented. This renders it impossible to close the mouth, and results in the condition of dislocation of the jaw, an accident distressing to the sufferer, who, however, presents a somewhat ludicrous appearance. This condition usually requires the presence of a surgeon for its relief.

Hip Joint.

The rounded head of the thigh bone or femur fits into a deep cup-shaped cavity or socket in the hip bone, thus forming a ball-and-socket joint. The joint surfaces of the bones are covered by smooth cartilage, and the bones are connected by a strong capsular ligament which entirely surrounds the joint. In positions where an excessive strain is apt to be developed this capsule is further strengthened by large bundles of ligamentous fibres. The capsule is connected above with the rim of the socket in the innominate, or

FIG. 20.—A SECTION OF THE HIP JOINT TAKEN THROUGH THE ACETABULUM OR ARTICULAR CUP OF THE PELVIS AND THE MIDDLE OF THE HEAD AND NECK OF THE THIGH BONE.

hip bone, and below with the neck of the femur, or thigh bone. Its inner surface is lined with synovial membrane. In the interior of the joint is another ligament, called the round ligament, passing from about the middle of the head of the femur to a rough depression at the bottom of the socket of the innominate. It is lined with synovial membrane, and plays but little part in holding the bones in place or in checking motion of the femur. Movement in this joint is in all directions, but is not as free as in the shoulder joint. The joint is rendered more secure and protected from injury by the large mass of muscle that surrounds it. On account of the great strength of the ligaments of this joint, dislocation of the head from its socket is rare, the femur itself more frequently breaking, while the ligaments hold firm. Dislocation of this joint, however, does sometimes take place, most commonly in adult life. In rare instances dislocation of this joint on one or both sides is found at birth, the accident having taken place during intra-uterine life.

SECTION III.

THE MUSCLES.

The great mass of the body is made up of the muscles, which form what is called flesh or meat. In athletic persons, in whom the muscles are well developed and are not covered with fat, they contribute most largely to the shape and weight of the body. The muscles are the organs of movement, and are made of reddish fibres having the power of contractility. There are two kinds of muscles: voluntary, or those under control of the will, and involuntary, or those over which the will has little or no control. The muscles of the arm or leg are examples of voluntary muscles, while the muscular fibres found in the bowels are of the involuntary variety.

Structure.

When we look at a voluntary muscle we find it to be made of bundles called the fasciculi, which in turn are composed of fibres. Examined under a microscope, each fibre is found to be marked by bands, or striæ, which run transversely or crosswise. From the appearance of these striæ, the term striped is applied to the voluntary muscles. If this muscular fibre be hardened in alcohol it will be further broken up into what are called fibrillæ. If we expose the fibre to the action of dilute acid, it will be broken up transversely into a series of disks or plates (Fig. 22).

Attachment.

The muscles, according to their intended use, are attached (1) by both ends to different bones; or (2) by one end to bone and by the other to some other organ of the body, as the skin; or (3) they may not be attached to bone at all, as is the case with

some of the muscles of expression in the face. Muscles are rarely attached directly, but usually through the medium of what are known as sinews or tendons. The tendons by which they are attached to the organ they are designed to move are white, glistening, fibrous cords,

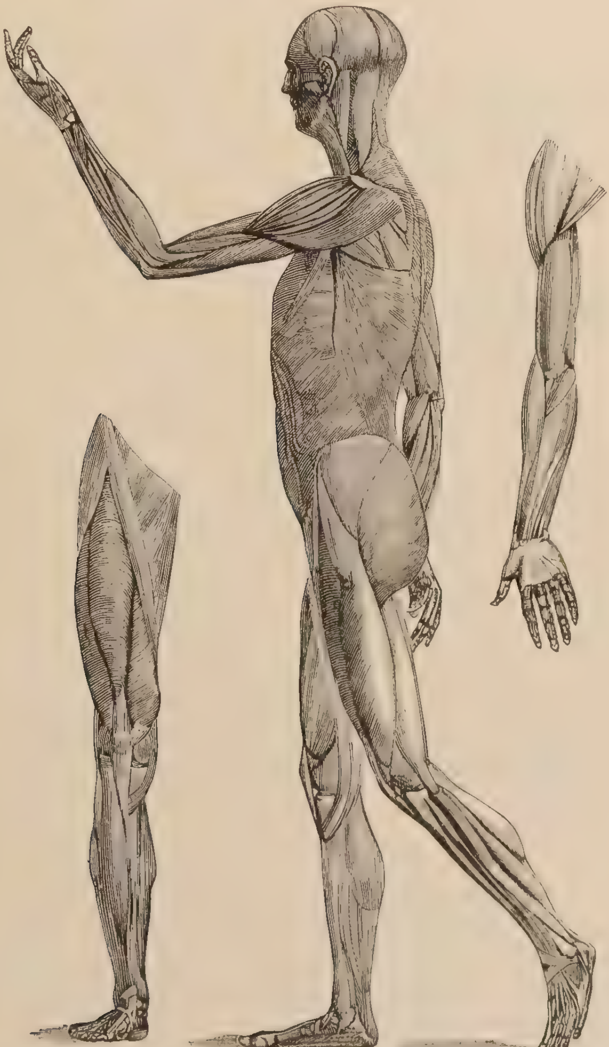

FIG. 21.—THE MUSCULAR SYSTEM.

inelastic and strong. They vary much in size and length, according to the size of the muscle of which they form a part and the distance of this muscle from the bone or other organ upon which it is designed to act.

Roughly speaking, a muscular fibre can contract until it is two thirds of its original length. The contraction of a muscle causes the distance between the two tendon ends to be shortened, and hence, one end being fixed and held immovable, the other end, with everything directly or indirectly attached to it, will be made to move. Muscles held in a state of active contraction very soon become tired, but in healthy individuals, when the fatigue is not excessive, they regain their full power after a short rest. This is true of both voluntary and involuntary muscles, and even the muscle of the heart, which seems to be in such constant action, really has a short period of rest after each beat. Besides this active contraction, which gives rise to motion, healthy muscles maintain almost constantly during consciousness a condition of passive contraction. This passive action of the muscles assists much in giving proper firmness to the body and extremities, and keeps the head and neck properly poised.

Action.

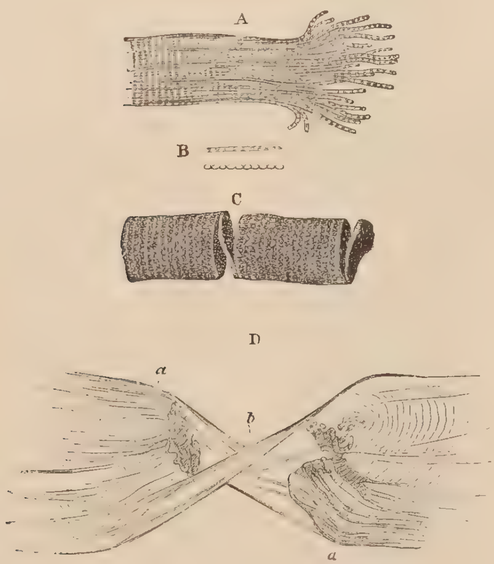

Fig. 22.

A, a muscular fibre, devoid of sarcolemma, and breaking up at one end into its fibrillæ; B, separate fibrillæ; C, a muscular fibre breaking up into disks; D, a muscular fibre, the contractile substance of which (*a*) is torn, while the sarcolemma (*b*) has not given way. (Magnified about three hundred and fifty diameters.)

Movements.

With the exception of the knee and of the foot below the ankle, all movements forward are known as "flexion" and all movements backward as "extension." In some muscles passing over only one joint the action is very simple, being limited either to plain flexion or extension. But many of the muscles by aid of their tendons pass over more than one joint, and then their action becomes much more complicated.

Biceps.

One of the muscles most commonly spoken of is the biceps, which occupies the front portion of the arm (Fig. 23). This muscle is attached above by two tendons, from which fact it derives its name of biceps. The shorter of these two tendons, which is on the inner side, is attached to that portion of bone, the coracoid process, which arches up from the shoulder-blade or scapula, and of

which mention has been made in the description of that bone. The other of the two tendons lies to the outer side of the short tendon. This, the long tendon of the biceps, passes over the shoulder joint, within the capsular ligament, and is attached to the upper rim of the shallow cup in the head of the scapula. To these two tendons the muscular portion or belly of the muscle is attached. The biceps muscle terminates below, a little above the bend of the elbow, in a single tendon, which passes downward in front of the elbow joint into the forearm, and is attached to the radius near its upper end and upon its inner side. This muscle can do many things according to what portions of the body or of the upper extremity are rendered fixed or immovable by the action of other muscles.

We shall now study some of these movements upon the right side. If we keep our left hand upon the right biceps we may feel the muscle contract when its action is being brought into play. If the body, shoulder, and arm are held still and the hand kept from turning, when the muscle acts it will simply flex the forearm upon the arm at the elbow joint. If the forearm is now held at right angles with the arm, and the palm of the hand turned downward, contraction of the biceps will turn the forearm over so that the palm of the hand will look upward. This action is called outward rotation, or supination of the forearm. While other muscles assist in these movements, the biceps is the strongest factor in producing them.

Fig. 23.—The bones of the upper extremity with the biceps muscle.

Because the upper tendons of the biceps pass over the shoulder joint, from their points of attachment on the scapula, to join the muscle, the action of the biceps assists in raising the whole upper extremity, and the whole action of the muscle is well shown during the using of a screw-driver, when the arm is raised at right angles with the body at the shoulder joint, the forearm flexed on the arm at the elbow, and the hand forcibly rotated outward in the act of driving a screw home. If, by grasping with firm hold upon some object, such as the limb of a tree, we fix the hand and forearm immovably, and then contract the biceps, these movements will be somewhat reversed; the arm will be flexed upon the forearm and the whole body will be carried along, so that if the limb of the tree of which we have hold is above the head, the body will be lifted from the ground.

A peculiar muscle in its shape and action is the diaphragm. This muscle is broad and thin, being shaped something like a palm-leaf fan

with the handle bent at right angles. It forms the partition wall between the chest cavity or thorax and the belly cavity or abdomen. The central portion of this large leaf consists of tendinous fibres, while the muscular fibres radiate from this central tendon. These muscular fibres are attached by their outer ends to the inside of the chest wall, and are connected in an oblique line with the breast bone in front, the lower six ribs at the sides, and the spine in the lumbar region behind.

Diaphragm.

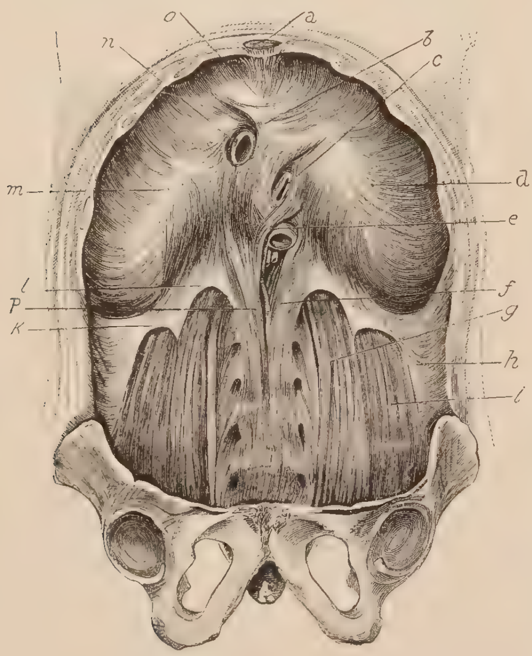

FIG. 24.—THE DIAPHRAGM.

a, the ensiform cartilage; *b*, the central tendon; *c*, the opening for the œsophagus; *d*, the left leaflet; *e*, the opening for the aorta; *f*, the left crus; *g*, psoas magnus; *h*, transversalis; *i*, quadratus lumborum; *k*, ligamentum arcuatum externum; *l*, ligamentum arcuatum internum; *m*, the right leaflet; *n*, the opening for the vena cava; *o*, the middle leaflet; *p*, the right crus.

The diaphragm is perforated by three large openings: one for the great artery, the aorta; one for the large vein coming from the lower part of the body and the lower extremities, the inferior vena cava; and the third for the gullet or œsophagus, as it passes down to reach the stomach. It is also perforated by smaller openings for the passage of other structures, such as nerves and small blood-vessels. The diaphragm is one of the muscles by which we breathe. When it is relaxed it arches up in the middle from its many points of attachment, so as to present a dome-like appearance; but when its muscular fibres contract, this curve becomes lessened and the dome is lowered, thus elongating the cavity of the chest or thorax and enlarging its capacity. At the same time the contents of the abdomen are pushed downward and the belly walls made to bulge forward. When this action occurs the lungs are expanded by the air which is forced into them from above through the mouth, and we have thus drawn in a breath. When we breathe out, an act performed by other muscles, the diaphragm plays a negative part and is relaxed and pushed up into its dome-shape by the organs of the abdomen, which have been forced upward by the action of the abdominal muscles.

The strongest tendon in the body is that by which the muscles forming the calf of the leg are fastened to the bone of the heel, and which is named the "tendo Achillis." It is six inches long and very thick and strong, being able to withstand the strain of over one thousand pounds. It receives its name from Achilles, the hero of the ancient Greeks, who, according to the old legend, was dipped into the river Styx by his mother and thus rendered invulnerable, except in the heel by which he had been grasped during the ducking.

Strongest Tendon of the Body.

SECTION IV.

ARTERIES, VEINS, AND CAPILLARIES.

The circulation of the blood through all portions of the body is carried on by means of (1) the heart, (2) the arteries, (3) the veins, and (4) the capillaries. The last serve to connect the arteries and veins together. The heart is the force-pump by which the constant current of the blood is maintained. It really consists of two pumps, a right and a left, which are intimately connected and work together. The right forces the blood through the pulmonary arteries into the lungs, whence, by means of the four pulmonary veins, it is brought back to the left side of the heart, and from here pumped out through the arteries to all portions of the body.

Heart.

The heart is a hollow muscle, conical in form, and so placed in the front and middle of the chest that the apex of the cone is directed downward, forward, and to the left. The throbbing of this apex is usually to be felt between the fifth and sixth ribs toward the left side. The upper border or base of the heart lies behind the sternum or breast bone, on a level with the second rib, and is covered by the lungs. The heart in the adult is about five inches long, and at its largest part three and a half inches broad and two and a half inches in thickness.

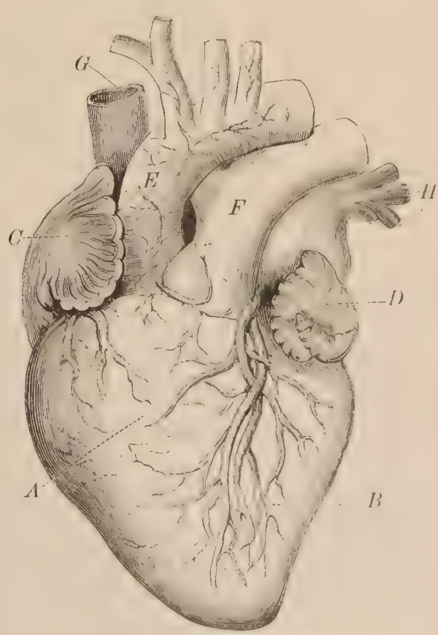

FIG. 25.—THE HEART AND LARGE BLOOD-VESSELS.

A, right ventricle; B, left ventricle; C, right auricle; D, left auricle; E, aorta; F, pulmonary artery; G, superior vena cava; H, left pulmonary veins.

The average weight in the male adult is from ten to twelve ounces, and in the female about two ounces lighter. The heart is divided by a partition running lengthwise into two halves, a right and a left. It is again divided by another partition running crosswise, so that each side has two compartments—the auricle, situated near the base, and the ventricle, which is situated toward the apex.

Between the auricle and the ventricle of the same side there is a large opening called the auriculo-ventricular, which is furnished with valves that allow the blood to pass from the auricle to the ventricle, but prevent this blood from returning again into the auricle when the ventricle contracts. These valves are made of strong but thin membrane, and look like inverted wall pockets arranged around a circular opening, so that when the blood is flowing from the auricle to the ventricle they are empty and flattened against the walls of the heart. As soon as the ventricle contracts and the blood contained in it tends to flow back through the opening, these pockets become filled with blood and distended, and, meeting in the middle of the opening, entirely block it up, thus preventing all regurgitation from the ventricle into the auricle. In order to prevent the valve from being forced bodily through the opening, the pockets have fastened to their free, unattached edges bands of strong fibres which, like guy ropes, hold them from going too far. These bands of fibres are the chordæ tendineæ, tendinous cords or "heart strings" of the heart.

Valves.

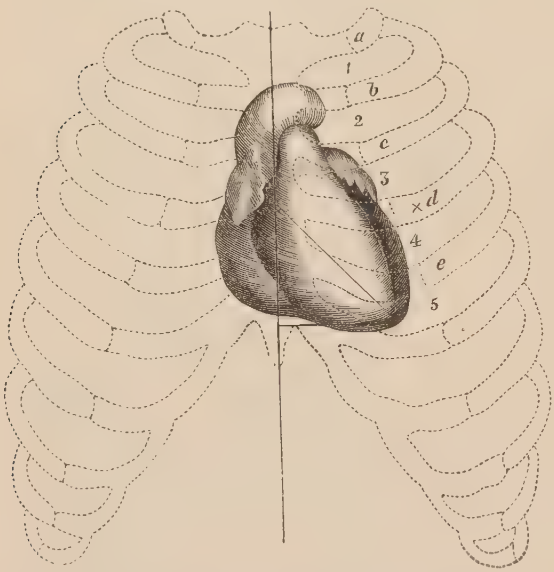

Fig. 26.—Heart and ribs.
a, b, c, d, e, ribs; 1, 2, 3, 4, 5, intercostal spaces; ×, position of nipple (fourth rib).

Besides the auriculo-ventricular openings which lead from one chamber of the heart to another, the heart has other openings. Into the right auricle there are the openings of the two greatest veins of the body: from above, the superior vena cava, through which flows the venous blood from the head, upper extremities, and upper portion of the body; and from below, the inferior vena cava, which conveys the venous blood

from the lower part of the body and lower extremities to the right auricle. Opening out of the right ventricle there is the pulmonary artery, which conveys the blood from the heart to the lungs. Into the left auricle there open the pulmonary veins, of which there are four—two for the right and two for the left lung. Out of the left ventricle opens the aorta, by which blood is conveyed into the general circulation. The openings from the ventricles into the pulmonary artery and into the aorta are guarded by valves which are in each case three-leaved, but are not supplied with chordæ tendineæ. These valves are named, respectively, the pulmonary valve and the aortic valve. The openings of the veins into the auricles are not provided with valves, and yet no regurgitation of blood occurs, for the contractions of the auricles are weak, the force with which the blood enters the auricles being the chief factor which carries it through the auricles into the ventricles, the auricles themselves playing little more than a passive part.

Circulation through the Heart.

To review, then, the course of the blood before going further, we shall start with the contraction of the right auricle. The contraction of the right auricle, with the force with which the blood comes from the great veins, carries the blood through the auriculo-ventricular opening into the right ventricle; the right ventricle immediately contracts, the blood is prevented from passing back into the right auricle by the tricuspid valve, and is forced out of the ventricle into the pulmonary artery. Regurgitation here is prevented by the pulmonary valves, and the blood travels on into the lungs, flowing through the capillaries here into the pulmonary veins; it is then carried into the left auricle, which then in its turn contracts, and the blood is conveyed into the left ventricle through the left auriculo-ventricular opening. Regurgitation into the auricle is prevented by the mitral valve, and when the left ventricle contracts, the blood is forced out into the aorta. The aortic valves situated here keep the blood from flowing back into the ventricle, and so the blood is carried on into the general circulation, where, after passing through the arteries and capillaries, it is returned to the right auricle by the veins, the last and largest of which are the superior and inferior venæ cavæ. Thus is the entire circuit completed.

It will be readily seen that the amount of work the different portions of the heart are called upon to perform is by no means equal for all of the parts. Thus the auricles have simply to pass the blood on into the ventricle, which is thus caused to dilate, and hence we find that there is very little muscular tissue in the walls of the auricles, as little muscular strength is required. The right ventricle must force the blood through the pulmonary arteries into and through the small capillaries of the lung, then back to the heart through the pulmonary veins. To accomplish this circulation, commonly referred to as the "lesser circulation" of the blood,

requires considerable force, and we find the walls of the right ventricle correspondingly well supplied with a thick layer of unstriped muscular fibres. But it is upon the left ventricle that the greatest amount of work is thrown, for this portion of the heart must force the blood to the most remote parts of the body, into and through the various organs, such as the liver, the kidneys, etc., and back again to the heart by means of the veins. Consequently, when we examine the heart, we find the walls of the left ventricle very much the most muscular of any, in order that it may properly perform its function of maintaining the current of blood in what is called the "greater circulation."

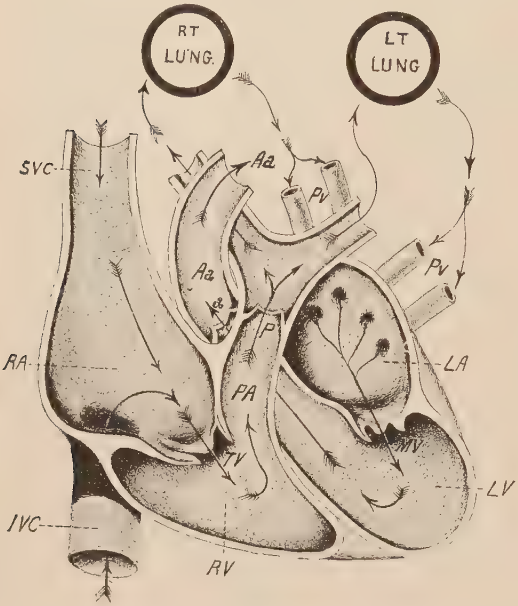

Fig. 27.—A schematic diagram of the heart, showing in one view the mechanical arrangement of the cavities and valves. (Designed and drawn by Dr. H. Macdonald.)

SVC, the superior vena cava; *IVC*, the inferior vena cava; *RA*, the right auricle; *TV*, the tricuspid valve; *RV*, the right ventricle; *PA*, the pulmonary artery; *P*, the pulmonary valve; *Pv*, the pulmonary veins; *LA*, the left auricle; *MV*, the mitral valve; *LV*, the left ventricle; *a*, the aortic valve; *Aa*, the aortic arch.

To facilitate the movements of the heart, it is surrounded by a sac composed of membrane similar to the synovial membrane which lines the joints, and which secretes a lubricating fluid. This sac is called the pericardium. The interior of the heart is also lined throughout with a delicate and very smooth membrane which is called the endocardium.

Arteries.

The arteries are tubes which convey the blood from the ventricles to every part of the body. They are composed of three layers or "coats"—an inner, an outer, and a middle. The inner coat is similar in appearance and structure to the smooth membrane lining the interior of the heart. The middle coat is composed partly of involuntary muscular fibres and partly of a kind of elastic tissue, so as to enable the artery to assist to a considerable extent in propelling the blood onward. The outer coat is formed of strong, firm tissue, which is also elastic. This coat gives to the arteries their great strength and the ability they possess to remain open when empty of blood. It is through

the action of the middle coat that most of the blood is forced out of the arteries into the capillaries and veins at the moment of death. In the dead subject the arteries are found open, but contain little blood, a fact which gave rise to the belief among the ancients that the arteries always contained air, and Cicero taught that they conveyed the "breath" from the lungs to the various portions of the body. Galen, in the second century, first pointed out the error, and showed that during life the arteries contain blood.

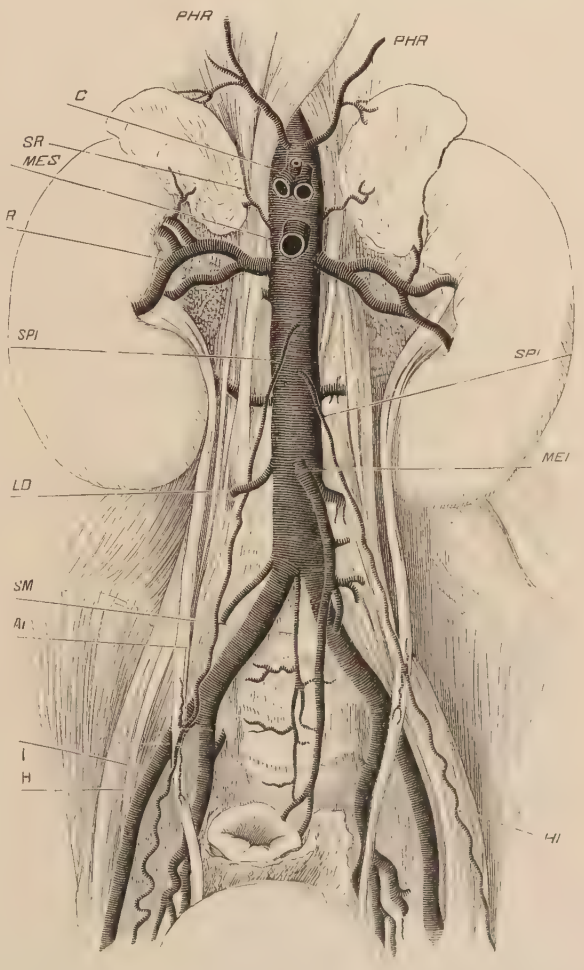

FIG. 28.—THE ABDOMINAL AORTA. (After Henle.)

AI, the common iliac artery; *I*, the external iliac; *II*, the internal iliac; *SM*, the middle sacral; *PHR*, the inferior phrenic arteries; *LD*, one of the lumbar arteries; *C*, the cœliac; *MES*, the superior mesenteric; *MEI*, the inferior mesenteric; *SR*, the capsular; *R*, the renal; *SPI*, the spermatic; *HI*, the internal hæmorrhoidal.

The largest artery in the body is the aorta. This great tube, which arises from the left ventricle, is the main trunk which carries the blood to all parts of the body. At first it passes upward and forward toward the right side of the body, then arches backward and to the left, and comes to lie upon the left side of the spinal column. It passes down along the left side of the bodies of the dorsal vertebræ, and, perforating the diaphragm, enters the abdominal cavity and reaches the fourth lumbar vertebra, where it divides into the right and left common iliac arteries. While arching over to reach the left side of the spine it sends out three very large branches, one of which soon divides into two, making in all four large arteries, the two nearer

the middle are the two common carotid arteries, a right and a left; these pass upward to supply the head and neck with many branches. The remaining two given off by the aorta as it arches backward and to the left are the subclavian arteries, a right and a left. The right subclavian lies to the right of the right common carotid, and the left subclavian lies to the left of the left common carotid artery. The subclavian arteries pass upward at first, then outward, down into the upper extremities to supply them with branches. The common carotid arteries pass upward obliquely through the neck, and a line drawn from the articulation of the clavicle or collar bone with the sternum or breast bone to a point just in front of the ear will nearly represent their course upon each side. At a point about on a level with the "Adam's apple" each common carotid divides into two arteries, an internal and an external carotid. The branches of one, the external carotid, supply mostly the outer portions of the head and face, while the branches of the other, the internal carotid, are distributed throughout the brain. The subclavian artery of each side at first arches upward behind the clavicle and then passes down and out between the clavicle and first rib. At this point the artery receives the name of axillary, and passes down below the shoulder joint through the axilla or armpit into the arm. When it reaches the arm this same arterial trunk is known as the brachial artery. The brachial artery passes down the arm, lying to the inner side of the biceps muscle,

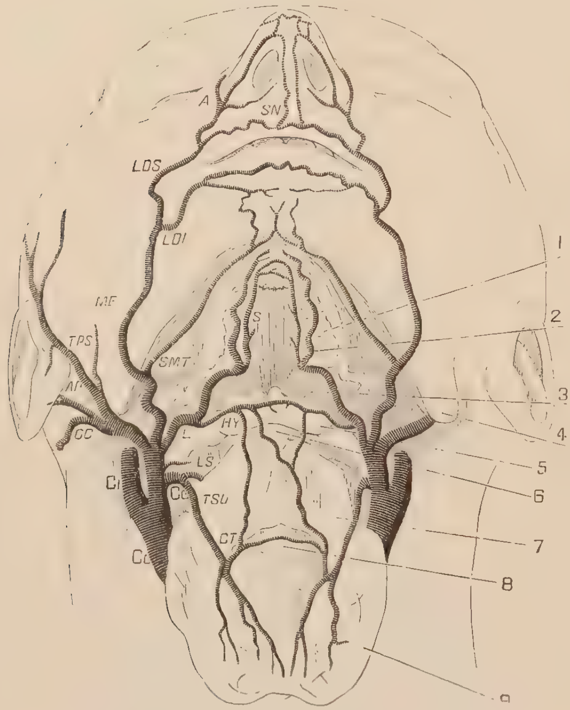

Fig. 29.—The external carotid artery and its branches. (After Henle.)

CC, the common carotid; *CE*, the external carotid; *CI*, the internal carotid; *TSU*, the superior thyroid; *LS*, the superior laryngeal and the crico-thyroid; *HY*, the hyoid branch of the lingual; *S*, the sublingual; *MF*, the facial; *SMT*, the submental; *LDI*, the inferior labial; *LDS*, the coronary of the upper lip; *SN*, the a. of the septum narium; *A*, the angular; *OC*, the occipital; *AP*, the posterior auricular; *TPS*, the superficial temporal; 1, the tongue; 2, the genio-glossus muscle; 3, the hyo-glossus; 4, the angle of the lower jaw; 5, the hyoid bone; 6, the thyro-hyoid ligament; 7, the thyroid cartilage; 8, the crico-thyroid membrane.

and, running across the front of the elbow joint nearly in the middle line, divides into the radial and ulnar arteries. It is the radial artery as it passes along the outer side of the wrist that is usually felt in counting the "pulse." The ulnar, though smaller and lying somewhat more deeply, can frequently be felt throbbing upon the inner side of the wrist. The long arterial trunk—known, according to its location, as the subclavian, the axillary, and the brachial artery—gives off numerous branches in its course, which are distributed to the neck, shoulder, and arm, while branches from the radial and ulnar arteries supply the forearm and hand with blood.

The aorta, as it passes on downward through the abdomen, gives off many branches to various organs of the body, such as the liver, the stomach and the intestines, the kidneys, the spleen, etc. When it reaches the fourth lumbar vertebra, as mentioned above, it divides into two very large branches—viz., the right and the left common iliac arteries. These common iliacs are short branches, being only about two inches long. Then they in turn divide, each into two large branches—an internal iliac, which supplies with blood the organs contained in the pelvis, together with the external genitals, and an external iliac, which passes downward, outward, and forward, leaving the abdominal cavity to supply the lower extremity. It passes into the thigh from the cavity of the abdomen at about the mid-point of the "groin," where it receives the name of femoral artery. This femoral artery passes down along the inner side of the thigh, and a line drawn from the middle of the groin to the inner side of the knee roughly indicates the position of the vessel. A little above the knee this same trunk passes behind the joint and becomes known as the popliteal artery. The popliteal artery divides just below the knee into two branches—an anterior and a posterior tibial artery. The anterior tibial supplies branches to the front of the leg and the upper surface of

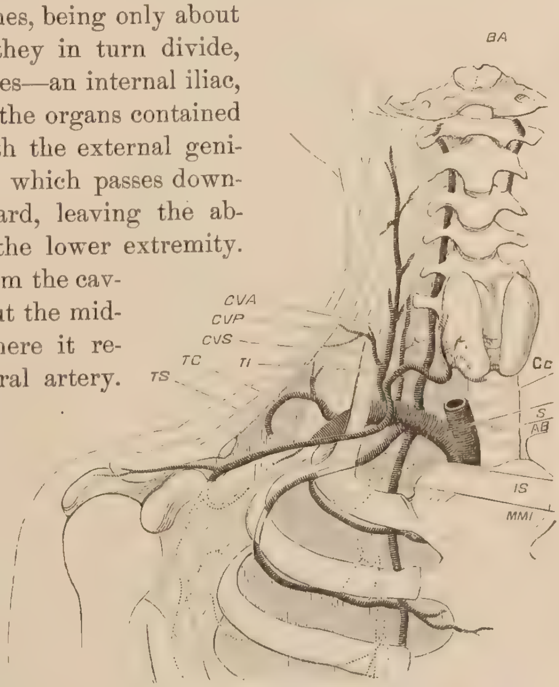

FIG. 30.—THE SUBCLAVIAN ARTERY. (After Henle.)
AB, the innominate; *CC*, the common carotid; *SA*, the subclavian; *V*, the vertebral; *BA*, the basilar; *MMI*, the internal mammary; *ES*, the superior epigastric; *MP*, the musculophrenic; *IS*, the superior intercostal; *CVP*, the deep cervical; *TI*, the inferior thyroid; *CVA*, the ascending cervical; *CVS*, the superficial cervical; *TS*, the suprascapular; *TC*, the posterior scapular.

the foot, while the posterior tibial furnishes branches to the back of the leg and to the sole of the foot.

Veins.

The veins, as already stated, return the blood to the heart from all portions of the body. They, like the arteries, are composed of three coats, but the middle coat of a vein is comparatively weak, and, owing to this fact, a vein, when empty, will collapse. The veins differ in another important particular from the arteries in that they are provided with valves. These valves are most numerous in the veins of the extremities, and they are usually composed of two leaves, sometimes of only one, and sometimes of three leaves. The valves are scattered along the course of the veins and prevent the blood from flowing in any way but one—namely, toward the heart. They are so arranged that they become filled and block up the calibre of the vein when the blood attempts to flow in the opposite direction—viz., away from the heart. Their position can be seen in the forearm if a moderately tight bandage is so placed around the arm as to retard the venous return but not compress the arteries, and the hand opened and closed a few times to increase the supply of blood to the forearm. Such a procedure will result in a distention of the veins with blood; they will stand out prominently, and at the same time the location of the valves will be seen readily. The four pulmonary veins which convey the

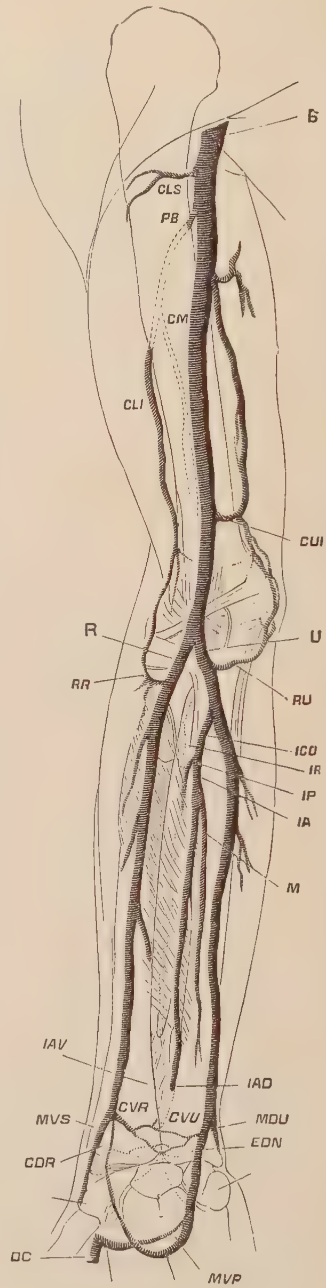

FIG. 31.—THE BRACHIAL ARTERY AND ITS BRANCHES. (After Henle.)

B, the brachial; *R*, the radial; *U*, the ulnar; *CLS*, the arteria deltoidea; *CLI*, the profunda radial; *PB*, the superior profunda; *CM*, the arteria collateralis media; *CUI*, the anastomotic a. of the arm; *RR*, the anterior radial recurrent; *RU*, the anterior ulnar recurrent; *ICO*, the common interosseous; *IA*, the anterior interosseous; *IP*, the posterior interosseous; *IR*, the posterior interosseous recurrent; *IAV*, the arteria interossea anterior volaris; *IAD*, the arteria interossea anterior dorsalis; *M*, the median; *CVR*, the anterior radio-carpal; *CVU*, the anterior ulno-carpal; *CDR*, the posterior radio-carpal; *MDU*, the posterior ulno-carpal; *MVS*, the superficial volar; *MVP*, the ulnar portion of the deep palmar arch; *DC*, the first palmar digital.

blood from the lungs to the left auricle, thus forming the return-channels of the "lesser circulation," are peculiar in two respects: they have no valves, and they contain "arterial" blood.

The veins of the "greater circulation" may be described as of two varieties, according to their situation, the deep and the superficial veins. The deep veins are placed deeply in the tissues and follow the course of the arteries; and the superficial veins, which are situated nearer the surface of the body, lie mostly just beneath the skin, where they can be seen readily, especially when made to stand out by the method spoken of above. In the neck, besides many smaller veins, we have upon each side one very large one called the internal jugular vein. This vein at first accompanies the internal carotid artery; lower down it follows the course of the common carotid to the root of the neck, where the internal jugular of each side is joined by the large subclavian vein which comes from the upper extremity. This junction of these two large veins forms the innominate vein upon each side, there being a right and a left. These two innominate veins join each

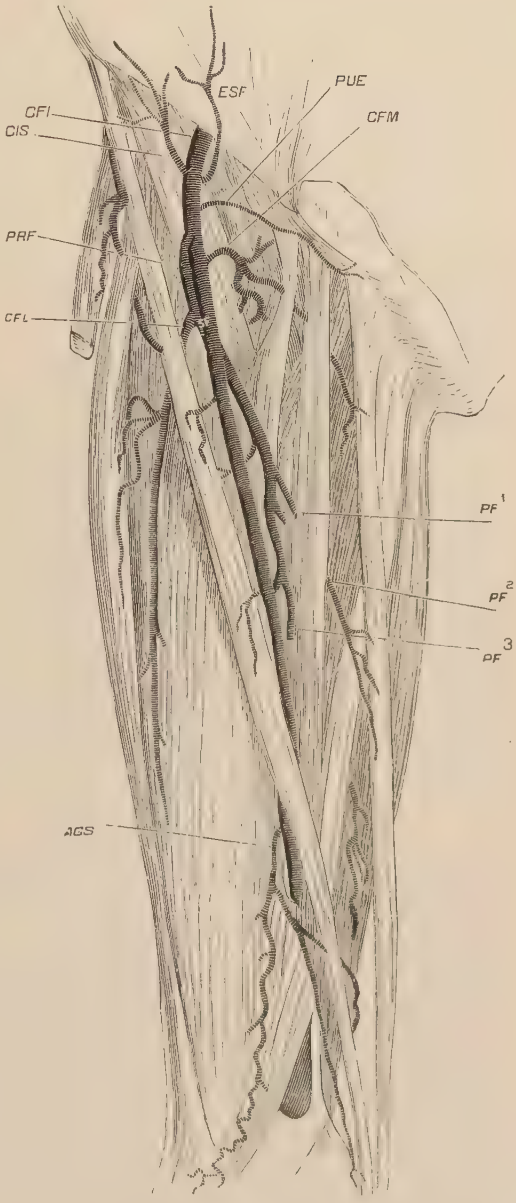

FIG. 32.—THE FEMORAL ARTERY. (After Henle.)

CFI, the common femoral; *ESF*, the superficial epigastric; *CIS*, the superficial circumflex iliac; *PUE*, the external pudic; *PRF*, the deep femoral; *CFL*, the external circumflex of the thigh; *CFM*, the internal circumflex of the thigh; *PF*[1], the first perforating a. of the thigh; *PF*[2], the second perforating a.; *PF*[3], the third perforating a.; *AGS*, the arteria anastomotica magna; *SF*, the superficial femoral.

other at an angle upon the left side of the median line of the body, and thus is formed the superior vena cava which empties into the right auricle, as already mentioned. The subclavian vein, which helps to form the innominate vein, is itself formed by the veins which come from the upper extremity, which are of the deep and the superficial variety.

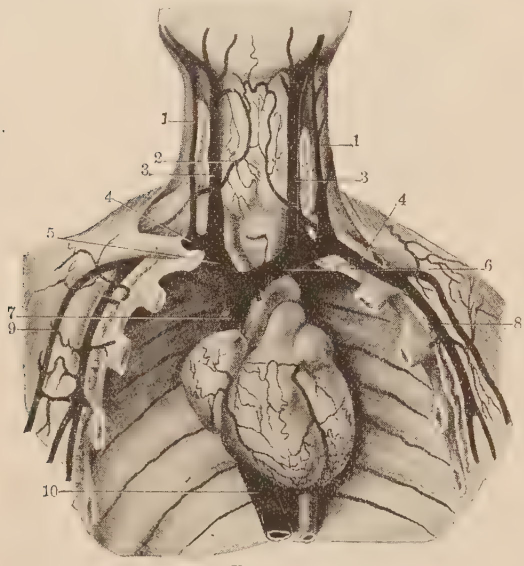

Fig. 33.

1, 1, the external jugular veins; 2, the right anterior jugular vein; 3, 3, the internal jugular veins; 4, 4, the subclavian veins; 5, the right innominate vein; 6, the left innominate vein; 7, the superior vena cava; 8, the left axillary vein; 9, the right cephalic vein; 10, the inferior vena cava.

The deep veins of the upper extremity accompany the arteries as in other parts of the body. The superficial veins are just beneath the skin in the greater part of their course, and are as follows: Ulnar and radial veins, upon the inner and outer sides of the forearm respectively, and, in the median line of the forearm, the median vein. At the bend of the elbow these veins join together so as to form two large veins—the basilic upon the inner side, and the cephalic, upon the outer side of the arm. The basilic vein joins with the deep veins of the arm and forms the axillary vein, which then receives the cephalic. Higher up the axillary becomes the subclavian vein, which soon joins the internal jugular to form the innominate vein, as already mentioned.

Veins of the Lower Extremity.

The veins of the lower extremity are divided into superficial and deep, as in the upper extremity, the deep veins accompanying the arteries and taking the same names. In the leg we have the anterior and posterior tibial veins, which join and form the popliteal vein, which lies behind the knee joint. Higher up in the thigh this vein is called the femoral until after it has passed through the groin into the belly cavity, where it receives the name of external iliac vein. As the vein passes through the groin it lies upon the inner side of the femoral artery. The superficial veins of the lower extremity are two in number: one, beginning by small branches upon the outer side of the foot, runs up the back of the leg, and behind the knee joint joins the deep vein, which is here the popliteal; the other superficial

vein of the lower extremity is longer, and, beginning upon the inner side of the foot, it courses upward upon the inner side of the leg and thigh until finally it empties into the femoral vein just before the latter becomes the external iliac. This superficial vein, called the long saphenous vein, and its branches, are subject to frequent inflammation, giving rise to what is known as "milk leg," and they also frequently become distended and dilated, resulting in the condition of "varicose veins."

Inside the abdominal cavity the external iliac vein is met by the internal iliac, which has come from the pelvic organs, and by the junction of these two veins upon each side of the body the common iliac veins, a right and a left, are formed. These two common iliacs in turn join together upon the right side of the aorta to form the inferior vena cava. This enormous vein passes up along the right side of the bodies of the vertebræ until, after passing through the diaphragm, it enters the right auricle of the heart. In its course the inferior vena cava receives some very large branches — notably the right and left renals, from the kidneys, and the hepatic, from the liver. The blood from the stomach and intestines, and from the pancreas and spleen, is collected by a system of veins known as *the portal system.* The smaller veins making up this system join together to form one large vein — the portal vein. This portal vein, instead of joining the inferior vena cava and returning the blood to the heart in this direct manner, enters the liver and breaks up into a network of branches, which

Inferior Vena Cava.

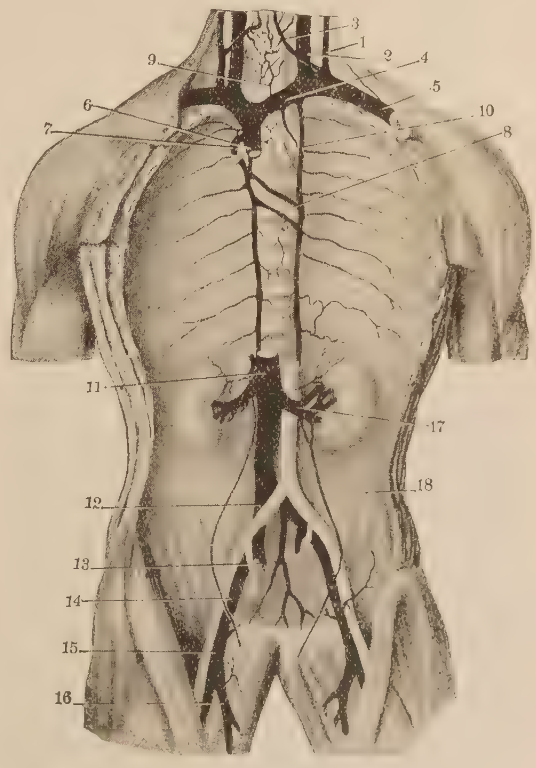

FIG. 34.

1, the left external jugular vein; 2, the left internal jugular vein; 3, the left anterior jugular vein; 4, the left innominate vein; 5, the left subclavian vein; 6, the superior vena cava; 7, the large azygous vein; 8, the small azygous vein; 9, the left inferior thyroid vein; 10, the left superior intercostal vein; 11, the inferior vena cava; 12, the right common iliac vein; 13, the right internal iliac vein; 14, the right external iliac vein; 15, the right femoral vein; 16, the right deep femoral vein; 17, the renal veins; 18, the internal spermatic vein.

again become joined into one large vein—the hepatic vein, already mentioned as opening into the inferior vena cava. From this arrangement it results that the hepatic vein returns from the liver not only the blood sent to it by the artery of the same name, but also that poured into it from the digestive organs through the portal system of veins.

Capillaries.

The capillaries are the exceedingly small vessels which connect the small terminal branches of the arteries with the small beginning branches of the veins. They average about one three-thousandth of an inch in diameter and are arranged in a fine and close meshwork, existing in nearly every portion of the body. They are composed of only one coat, which is continuous with the internal smooth coat of the larger vessels, though in the capillaries it is even more delicate than in the large vessels. This very thin wall allows the oxygen and the nutritious properties contained in the blood to pass out into the tissues, and the carbonic-acid gas and other results of tissue waste to pass from the tissues into the blood.

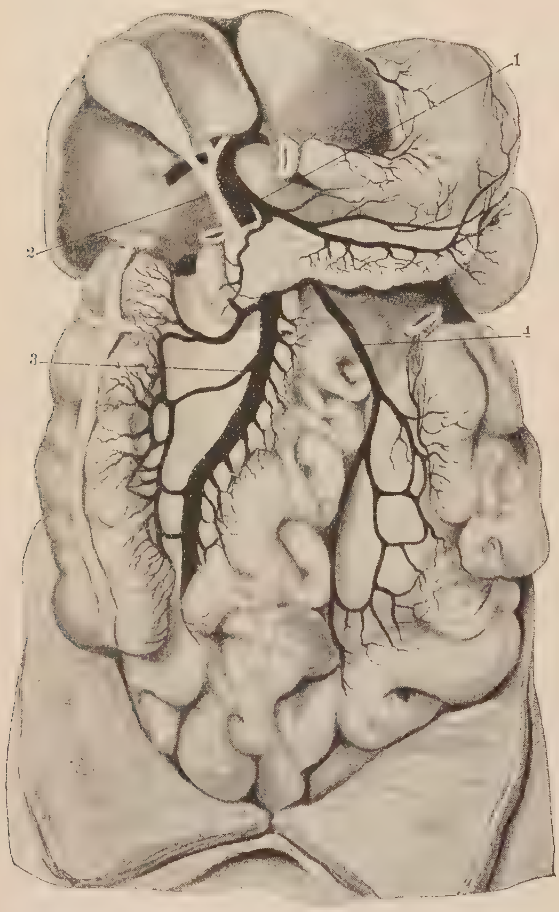

FIG. 35.
1, the splenic vein; 2, the portal vein; 3, the superior mesenteric vein; 4, the inferior mesenteric vein.

Almost all of the blood-vessels communicate freely with one another—the arteries with other arteries, the veins with other veins, and the capillaries with other capillaries. These frequent communications or "anastomoses" enable the circulation to be maintained, even if a very large vessel should become closed or should be tied by the surgeon. For example, if the brachial artery should be

tied; for a short period of time the limb below the ligature would become cold and apparently bloodless, but soon an increasing amount of blood would reach it through the communications between the branches of the brachial artery and of the axillary artery above the ligature, and the branches of the brachial and of the radial and ulnar arteries below the ligature. This increased flow of blood through the small branches soon results in their becoming larger, and one or more of them will become so large that as much blood will reach the limb below the obstruction as before, and thus the nutrition of the part is maintained. Such a course of events is known as the establishment of the "collateral circulation." The most important exception to the frequent communication of the small arteries is found in the brain, where the small or "terminal" arteries do not anastomose, and hence, when one or more of them become blocked or plugged, that portion of the brain supplied by the artery will be deprived of blood and will become softened and degenerated.

Communication of Blood-Vessels.

SECTION V.

THE LYMPHATICS.

Besides the vessels which act as channels for the circulating blood, and which have been described in the previous chapter, there are present in nearly every portion of the body other vessels, called the lymphatics, on account of the resemblance of the fluid contained in them to water (Latin, *lympha*). These vessels are also called the "absorbents," from their function of absorbing materials from all parts of the body containing them, which material they convey finally into the circulating blood, as will presently be seen. The lymphatic vessels of the small intestine are known as the lacteal or chyliferous vessels, because during the digestion of the food they become filled with a milk-white fluid called the chyle, which has been absorbed from the intestine and represents the products of the digestive process. The lymphatics are very delicate vessels with transparent walls, so that their contents may be easily seen through them. The larger vessels have, like the arteries and veins, three coats—all very thin; but the smaller lymphatics have only one coat, the internal, as in the capillaries. There is, however, not so much variation in size among the lymphatic vessels as is seen in the arteries and veins. These lymphatic vessels form nets or meshwork all over the body, and, like the veins, they are supplied with valves, but much more abundantly, so that they have the appearance of knotted threads. They are not arranged as a tree with branches, but have a resemblance more to

Lacteals.

a complicated tangle of threads (Fig. 36). They are arranged in two sets, superficial and deep; but these two sets have very frequent communication with each other.

Lymphatic Glands. Besides the lymphatics and the lacteal vessels there exist numerous lymphatic glands, situated in various parts of the body, and with which are connected the lymphatics and lacteals in their immediate neighbourhood. Some of the lymphatics open *into* the glands and convey the lymph from the surrounding tissues to the interior of the gland structure, while other vessels open *out* of the gland, and carry the lymph *from* the gland. These vessels communicate with others which in turn empty into some other neighbouring gland. The glands vary in size from a pin's head to an almond. Some belonging to the superficial set are situated in the head around the ear, under the jaw, and in the neck, while other superficial glands are found in the upper extremity, in the armpit or axilla, and a single one upon the inner side of the arm just above the elbow, while in the lower extremity they occur mostly in the groin; but there is usually one or more behind the knee joint in the popliteal space.

Fig. 36.—Lacteals and lymphatics during digestion. (Dalton.)

The lymph and chyle of the body are finally collected by two main vessels, one of which is small, being the common lymph channel for the right side of the head and neck, the right upper extremity, the right side of the thorax and what it contains—viz., the right lung and right side of the heart—and also for the upper surface of the liver. This common channel is called the right lymphatic duct. The left lymphatic duct is much longer and larger than the right, and, from its course, is known as the thoracic duct. This thoracic duct conveys the lymph and chyle from all portions of the body which are not enumerated above as supplying the right duct. The thoracic duct is about sixteen inches long, and, beginning in the loin

or lumbar region of the abdomen, it extends upward along the bodies of the vertebræ, passes through the same opening in the diaphragm through which the aorta goes, and enters the cavity of the thorax. It then passes on up until it reaches the seventh cervical vertebra, when it arches forward to its termination. At its commencement upon the second lumbar vertebra, where it receives many large branches, the thoracic duct is dilated into a sac of considerable size, but farther up the duct is about the size of a goose quill. The right lymphatic duct and the thoracic duct empty respectively into the right and into the left subclavian veins, near their junction with the internal jugular veins, upon each side of the root of the neck. During and following the digestion of food the thoracic or left lymphatic duct is gorged with the chyle which has been collected from the intestine, and which it receives and conveys into the general circulation by pouring it into the left subclavian vein. The openings of the right duct into the right subclavian vein and of the thoracic duct into the left subclavian are protected by valves which prevent the blood from flowing into the ducts, but allow the lymph and chyle to pass from the ducts into the veins. Both of the ducts are well supplied with valves throughout their course. The lymphatic vessels lying beneath the skin can sometimes be seen as red lines running from the neighbourhood of poisoned wounds toward the nearest lymphatic gland or bunch of glands.

Lymphatic Ducts.

SECTION VI.

THE NERVOUS SYSTEM.

The nervous system of the body is composed of two distinct kinds of elements which are closely associated together in their functions and in their anatomy. One, the nerve-cell, is for the production of impulses and for the receipt of impressions; and the other, the nerve-fibre, is for the transmission of these impulses and impressions to and from various localities. The first of these elementary varieties, then, is the nerve-cell or nerve-corpuscle.

Nerve-cells are composed of finely granular matter, and are of a reddish or yellowish-brown colour. They vary much in size and shape, some being small and others large; some are rounded, some angular, and still others stellate in shape (Fig. 37). The last, stellate-cells, are especially characterized by having one of their processes much prolonged. This process is the beginning of a nerve-fibre. All of the nerve-cells have one or more prolongations or processes which are very delicate; some of these processes apparently serve to

Nerve-cells.

connect the cell with neighbouring or distant cells, while others become continuous with, and seem to give origin to, a nerve-fibre. Where the nerve cells or corpuscles are collected together in masses, we have what is known as the "gray matter" of the nervous system, as distinguished from the "white matter," which is composed chiefly of the nerve-fibres. This gray matter, representing an aggregation of nerve-cells, is found upon the outer surface or cortex of the brain and cerebellum, in smaller masses in the interior of these organs, and in the interior of the spinal cord. It not only exists in these comparatively large masses, but is also found in smaller accumulations in various parts of the body, as will be seen later. These aggregations of cells, forming larger and smaller masses of gray matter, are the nerve-centres of the body.

Fig. 37.—Multipolar ganglion cells from the human brain. 1, a cell, one of whose processes (*a*) becomes the axis cylinder of a nerve-fibre (*b*); 2, a cell (*a*) connected with another (*b*) by means of a commissure (*c*); 3, diagram of three cells (*a*) connected by means of commissures (*b*), and running into fibres (*c*); 4, a multipolar cell containing black pigment.

The nerve-fibres constitute what is known as the white matter of the nervous system and make up the nerve-cords of the body, and form the greater bulk of the brain where they are in the interior, and also of the spinal cord where they occupy the exterior. There are two kinds of nerve-fibre. One is called the medullated, and this is the variety which is found almost everywhere throughout what is known as the cerebro-spinal nervous system—viz., that system which consists of the brain and spinal cord and their branches, and which controls the animal functions of the body, such as sensation and motion, and the special senses. The other variety of nerve-fibre is called the non-medullated, and goes to form almost entirely the nerve-cords of the sympathetic nervous system, which system has control over the vegetative functions of the body, such as circulation and digestion, in contradistinction to those functions which are the special attributes of animals.

Nerve-fibres.

The nerve-fibres of the cerebro-spinal system are, as has been said, of the medullated variety. Such a nerve-fibre consists of (1) a central portion, transparent, of the consistence of the boiled white of an egg, and which forms the true conducting portion of the nerve-fibre. This central portion, which is the fundamental portion of a nerve-fibre, is the axis cylinder. Around this axis cylinder is placed a layer of liquid fat, the medullary sheath (2), which incloses the axis cylinder, protecting it and *insulating* it, and is in turn surrounded and held in place by (3) a thin, delicate, membranous covering, the neurilemma or real sheath of the nerve-fibre. From this description the similarity in structure between an insulated telegraph wire and a nerve-fibre will be readily seen, and as both have similar functions, the analogy is most striking. These nerve-fibres vary from $\frac{1}{1200}$ to $\frac{1}{2000}$ of an inch in size.

FIG. 38.—THE CEREBRO-SPINAL SYSTEM OF NERVES.

The non-medullated nerve-fibres make up the great portion of the nerves of the sympathetic system, and are also found in some of the cerebro-spinal nerves, notably in the nerve of the special sense of smell — the olfactory nerve. These non-medullated nerve-fibres seem to consist of an axis cylinder somewhat larger than in the medullated fibre, but having no insulating fatty envelope around it, being protected only by a thin membranous sheath. Such a nerve-fibre is about half the size of the medullated variety.

When the nerve-fibres are collected into bundles or cords of larger or smaller size they form the nerves.

The cerebro-spinal system consists of the brain and the spinal cord as the nerve-centres, and the nerves emanating from them (Fig. 38).

The Brain.

The brain or encephalon is contained within the bony cavity of the cranium. It is divided into four principal parts—viz, the cerebrum, the cerebellum, the pons Varolii, and the medulla oblongata (Fig. 39). The encephalon increases rapidly in size up to the seventh year, then more slowly and with increasing slowness, until at forty it reaches its maximum, which is about forty-nine ounces for the male and forty-four for the female. The size of the brain can not be said to bear a direct relation to the intellectual capacity of the individual, for, while some learned men have had brains which weighed as much as sixty-three and sixty-four ounces, persons of less than ordinary intellectual-development have had brains weighing as high as sixty-eight ounces. Man has the heaviest brain of all animals, with the exception of the elephant and the whale.

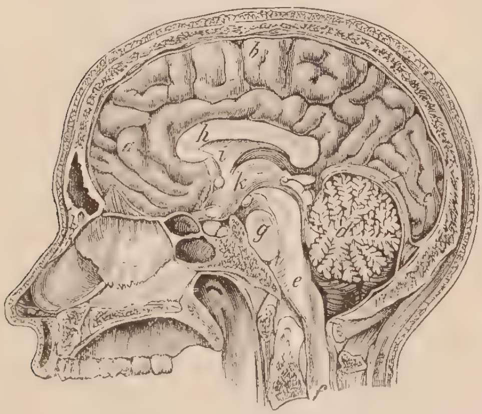

Fig. 39.—A vertical median section of the brain inclosed in its membranes and the skull.

a, *b*, *c*, convolutions of the cerebrum; *d*, the cerebellum; *e*, medulla oblongata; *f*, the upper end of the spinal cord; *g*, pons Varolii; *h*, corpus callosum; *i*, fornix; *k*, the gray commissure.

Membranous Coverings of the Brain.

The brain, as it lies in the cavity of the skull, is protected by three membranous coverings, named, from without inward, the dura mater, the arachnoid membrane, and the pia mater. The dura mater, the most external of these coverings, is the thickest, being dense and inelastic, and lines the internal surface of the cranial cavity, where it adheres to the bone, forming for them an internal periosteum. Along the middle line above, a sickle-shaped process of the dura passes vertically downward into the great longitudinal fissure between the two hemispheres, and forms the falx cerebri. In the back of the cranial cavity another process of dura, which is horizontal, passes inward from the circumference of the skull to support the posterior lobes of the cerebrum, separating the cerebrum from the cerebellum, which lies below it. This process is called the tentorium cerebelli. The two lateral halves of the cerebellum are likewise partially separated by a vertical process of the dura, the falx cerebelli. The

arachnoid is a delicate membrane which separates the dura from the pia mater. Between the dura mater and the arachnoid membrane is the subdural space, small but filled with fluid; and between the arachnoid and the pia is the subarachnoid space, wider than the former, and also filled with a fluid known as the cerebro-spinal fluid. This subarachnoid space communicates with cavities in the interior of the brain. The pia mater is essentially a vascular membrane, being composed of blood-vessels held together by fine threads of connective tissue. It invests the surface of the brain closely, dipping down into the fissures and sulci, and it penetrates into the interior of the brain and lines its cavities.

The Cerebrum.

The cerebrum is the largest part of the encephalon, and occupies the whole upper portion of the cavity of the skull (Fig. 40). It is nearly divided into two distinct lateral halves or hemispheres by a deep fissure—the great longitudinal fissure—which runs from before backward in the median line. The portion of the cerebrum which is not so divided, and which is left to bind the right and left hemispheres together, is near the under surface of the brain, and is called the corpus callosum. This structure can be seen at the bottom of the great longitudinal fissure when the hemispheres are held slightly apart. When the hemispheres are examined one is immediately struck with the many folds or convolutions which appear upon their outer surface. The external surface of these convolutions is composed of the gray matter forming the cortex of the brain, while their interior is composed of white matter. By such a plan the amount of gray matter possible for a given space within the cranium is much increased, and the human brain has more and deeper convolutions than the brain of any other animal.

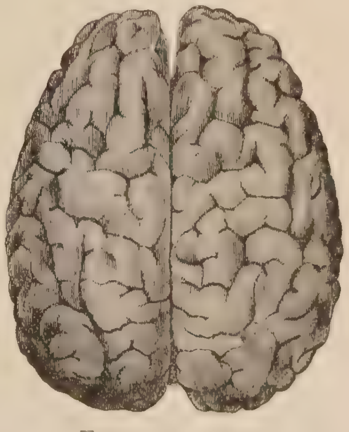

Fig. 40.—Upper surface of the cerebrum, showing the convolutions of the brain and its double structure.

While the arrangement of the convolutions differs considerably in different brains, and even upon the two sides of the same brain, there is still apparent a certain plan or design upon which they occur. The clefts between the convolutions when they are small are called sulci, but when large they are known as fissures. There are five great fissures (Fig. 41): (1) The great longitudinal fissure, already mentioned, which separates the cerebrum into two hemispheres, and (2) the great transverse fissure, which separates the cerebrum from the cerebellum. Each hemi-

sphere is divided into lobes by the three remaining fissures: (3) the fissure of Sylvius, which separates the parietal from the temporo-sphenoidal lobe; (4) the fissure of Rolando, which separates the frontal lobe from the parietal; and (5) the parieto-occipital fissure, which separates

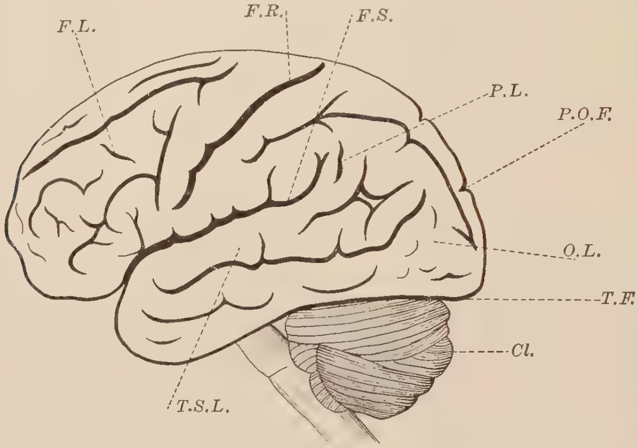

FIG. 41.—DIAGRAM OF THE OUTER HEMISPHERE.

F. R., fissure of Rolando; *F. S.*, fissure of Sylvius; *T. F.*, transverse fissure; *P. O. F.*, parieto-occipital fissure; *F. L.*, frontal lobe; *P. L.*, parietal lobe; *O. L.*, occipital lobe; *T. S. L.*, temporo-sphenoidal lobe; *C. L.*, cerebellum.

the parietal from the occipital lobe, and is seen well only when the two hemispheres are severed, for it is upon their inner and opposing surfaces. Besides these four lobes—the frontal, the parietal, the temporo-sphenoidal, and the occipital—there is a collection of gray matter at the bottom of the fissure of Sylvius, near the base of the brain, which is known as the central lobe, or the island of Reil.

Each of these lobes, with the exception of the last, is marked off by numerous sulci into convolutions, and all these sulci and convolutions have been mapped out and named and studied, and it has been found that certain portions of the cerebral cortex are always occupied by certain centres, and from these centres the same impulses always originate. Thus, for example, the centre in the brain which controls the movements of the right leg and foot in walking is situated just behind the upper end of the fissure of Rolando near the great longitudinal fissure on the left side.

If we turn the brain over and examine its under surface or base (Fig. 42), we find the cerebrum divided into two lateral halves by the great longitudinal fissure, and each half further divided into three lobes—an anterior in front of the Sylvian fissure, a middle lobe back of this fissure, and a posterior lobe which is covered by the cerebellum. Emerging from various points upon the base of the brain we see many

of the nerves of the cranium. In front, upon the under surface of each frontal lobe, is seen the olfactory nerve ending in the olfactory bulb; just behind this we see the two optic tracts, which meet in the centre, forming the optic commissure, and diverging again as the optic nerves. In the median line in front, showing between the slightly separated hemispheres, is seen the anterior or front portion of the corpus callosum. Just in front of the optic commissure is seen a small mass which seems to be in some way connected both with the nervous and with the glandular systems of the body; this is the pituitary body or

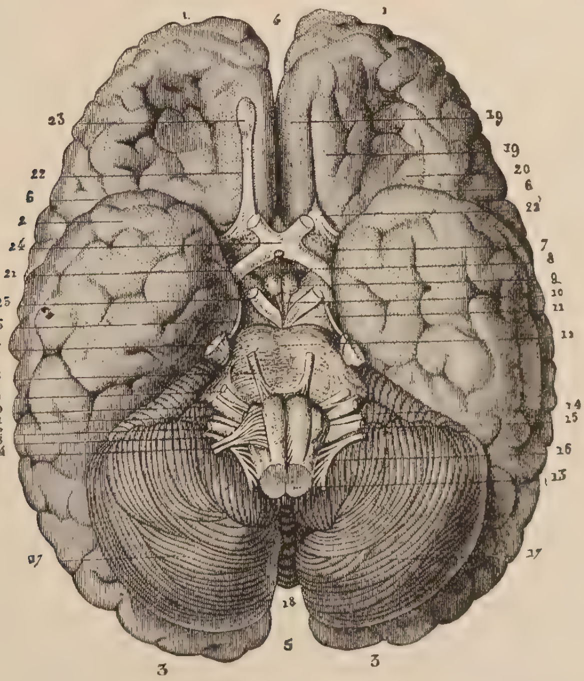

FIG. 42.—THE BASE OF THE BRAIN. (From Ranney, after Hirschfeld.)

1, 1, anterior lobe of the cerebrum; 2, sphenoidal portion of the posterior lobe; 3, 3, occipital portion of the same lobe; 4, anterior extremity of the median fissure; 5, posterior extremity of the same; 6, 6, fissure of Sylvius; 7, anterior perforated space; 8, tuber cinereum and pituitary body; 9, corpora albicantia; 10, interpeduncular space (posterior perforated space); 11, crura cerebri; 12, pons Varolii; 13, medulla oblongata; 14, anterior pyramids; 15, olivary body; 16, restiform body (only partially visible); 17, 17, hemispheres of the cerebellum; 18, fissure separating these hemispheres; 19, 19, first and second convolutions of the inferior aspect of the frontal lobe with the intervening sulcus; 20, external convolutions of the frontal lobe; 21, optic tract; 22, olfactory nerve; 22′, section of the olfactory nerve, showing its triangular prismatic shape; the trunk has been raised to show the sulcus in which it is lodged; 23, ganglion of the olfactory nerve; 24, optic chiasm; 25, motor oculi; 26, patheticus; 27, trigeminus; 28, abducens; 29, facial; 30, auditory nerve and nerve of Wrisberg; 31, glosso pharyngeal; 32, pneumogastric; 33, spinal accessory; 34, hypoglossal.

gland. Lying partly hidden by the optic tracts are two diverging bundles of white matter, the crura cerebri, which are made up of nerve-fibres coming through the pons Varolii from the medulla oblongata and from

the spinal cord. These fibres, which make up the crura cerebri, pass on into the substance of the brain. From the inner side of each crus is seen emerging the third cranial nerve, and from the outer side the fourth cranial nerve. Further back is seen the pons Varolii, another mass composed mostly of nerve-fibres, some of which pass laterally between the two lobes of the cerebellum, and others, mentioned above, pass from the medulla upward into the brain to form the crura cerebri. Emerging from the pons is the fifth pair of cranial nerves, and just behind the pons, from the groove between it and the medulla, the sixth pair of nerves make their exit. Behind the pons Varolii is seen the medulla oblongata, the upper expansion of the spinal cord. From the medulla pass the remaining six of the twelve pairs of cranial nerves.

The Interior of the Brain.

If from a brain held in the natural position, with its base downward, we slice off the hemispheres down to the level of the corpus callosum, we find a large expanse of white matter surrounded by the gray matter of the cortex, and the indenting fissures and sulci with their gray matter. In such a section the corpus callosum will be exposed, and it can be seen to be composed of transverse white fibres which connect together two hemispheres of the cerebrum. Such a band of connecting fibres is known as a commissure, and the corpus callosum forms the great transverse commissure of the hemispheres. Just beneath the corpus callosum is a band of fibres passing between the front and the back portions of the brain. These fibres form a longitudinal commissure which is called the fornix.

If the brain be again sliced so as to take off still more of the hemispheres and also to remove the corpus callosum and the fornix, the two lateral ventricles of the brain will be opened into. These interior cavities of the brain are of irregular shape, and are composed of a main cavity, or body, and an anterior, a posterior, and a middle horn. The ventricles are situated one upon each side and communicate below with the subarachnoid space before referred to, and are lined by a delicate membrane. A process of the pia mater, the velum interpositum, is continued from the exterior of the brain into each ventricle, and covers a portion of its floor, and the edge of this velum interpositum is occupied by a highly vascular fringe called the choroid plexus. At the bottom of each lateral ventricle, and projecting into its cavity, are two of the large collections of gray matter or nerve-cells which exist in the interior of each hemisphere. In front is seen a portion of one of these masses called the corpus striatum, while behind, the optic thalamus, the other of the two collections of gray matter, bulges into the cavity of the ventricle. The two lateral ventricles, forming the first and second ventricles of the brain, are separated by a vertical sæptum composed of two layers of membrane having between them a space which is called the fifth ventricle.

Behind this and between the two optic thalami is another space called the third ventricle, situated in the median line. The two lateral ventricles and the third ventricle communicate with each other and also with another cavity situated in the medulla—viz., the fourth ventricle—by means of a Y-shaped canal, the foramen of Monro. Before birth in man, and in the adult in some animals, the fifth ventricle communicates by an opening with the third, but in the human adult it is isolated from the general ventricular space constituted by the four other ventricles and the central canal of the spinal cord.

Of the two large masses of gray matter which project into the lateral ventricle, the corpus striatum is composed only in part of nerve-cells, for it contains many diverging white fibres which give to it a striped appearance, whence its name. The greater portion of the body of the corpus striatum is embedded in the white substance of the hemisphere, but a small portion of it, which arches backward, can be seen, as stated, at the bottom of the lateral ventricle in front and to the outer side. This process of the corpus striatum that arches back is separated from the main portion by a bundle of white fibres which ascend from the cord through the pons, medulla, and crura, on their way to the surface of the brain, and form the internal capsule, the name external capsule being applied to the white matter upon the outer side of the main portion of the corpus striatum.

The optic thalami are two large masses of nerve-cells which lie one upon each side of the median line, and which project up into the floor of the lateral ventricles between the corpora striata. They are covered by a layer of white matter, but their interior is composed of gray matter.

The cerebrum has been likened to a tree, the trunk of which is formed by the medulla, which divides into two main branches, the crura cerebri, and these branches in turn dividing, until finally the smallest twigs are formed. These twigs have upon their extremities leaves, represented by nerve-cells, forming the mass of foliage or the cortex of the brain. But the analogy is incomplete, for in the cerebrum there are masses of gray matter in its interior. The two largest of these in each hemisphere are the corpus striatum and the optic thalamus, of which we have spoken above; but besides these two there are other smaller masses of gray matter existing in the interior of the cerebral substance. The white matter of the cerebrum consists of medullated fibres, and these fibres are arranged into three classes, according to the office they perform and the direction they take:

(1) The main body of the white matter originates in the spinal cord and passes upward, and in the brain they appear as the diverging crura cerebri and the internal capsule.

(2) The transverse commissural fibres connecting the two hemispheres and found mostly in the corpus callosum.

(3) The commissural fibres connecting different parts of the same hemisphere, of which the fornix is an example.

The Cerebellum.

The cerebellum, or little brain (Fig. 42), is that portion of the brain which is situated below the process or offshoot of the dura mater, mentioned above as the tentorium cerebelli, and it lies below the posterior lobes of the cerebrum. The average weight of the cerebellum in the male adult is five ounces and a half, and its proportion to the cerebrum is about as one to eight and a half in the

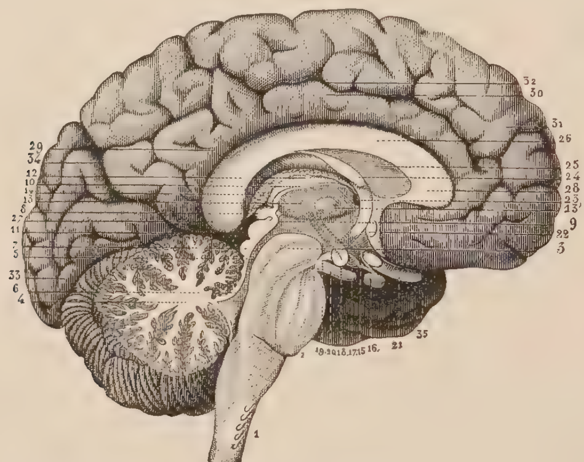

FIG. 43.—A VERTICAL SECTION OF THE BRAIN. (From Flint, after Hirschfeld.)

1, medulla oblongata; 2, tuber annulare; 3, cerebral peduncle; 4, cerebellum; 5, aqueduct of Sylvius; 6, valve of Vieussens; 7, tubercula quadrigemina; 8, pineal gland; 9, inferior peduncle; 10, superior peduncle; 11, middle portion of the great cerebral fissure; 12, optic thalamus; 13, 13, gray commissure; 14, chorioid plexus; 15, infundibulum; 16, pituitary body; 17, tuber cinereum; 18, bulb of the fornix; 19, anterior perforated space; 20, root of the motor oculi communis; 21, optic nerve; 22, anterior commissure of the cerebrum; 23, foramen of Monro; 24, section of the fornix; 25, septum lucidum; 26, 27, 28, corpus callosum; 29, 30, 31, 32, 33, 34, convolutions and sulci of the cerebrum. The olfactory ganglia and corpora striata are not shown in this section.

adult and only one to twenty in the infant. It is oblong in shape, its longest diameter, three and three quarters inches, being transverse. It is constricted in the centre, where it measures only half an inch in circumference, and is like the cerebrum in that it is composed of gray and white matter, the white matter being on the interior and the gray matter mostly upon the outside. The surface of the cerebellum is not thrown into convoluted folds just as is the cerebrum, but is traversed by numerous furrows, or sulci, which vary much in depth; some are rather shallow while others are deep (Fig. 43).

In man the cerebellum is composed of two large lateral hemispheres which are connected together by means of a central portion or lobe. This

median lobe is the essentially fundamental part of the cerebellum, and in some of the lower animals, as the fishes and reptiles, it is the only portion which exists. The lateral hemispheres are a feature of higher animal life. They reach their greatest development in man. The hemispheres are separated in front and behind by a median notch or fissure. In the fissure behind is received a process of dura mater which projects forward from the wall of the skull in a manner similar to the falx cerebri in the cerebrum. This process is known as the falx cerebelli.

Each hemisphere of the cerebellum is divided into lobes, but the division is not so distinct as in the greater brain. If we make a longitudinal vertical section of a hemisphere just to one side of the median fissure we have an appearance such as is shown in Fig. 43. The peculiar arrangement of the gray and white matter upon the cortex has led to the name "arbor vitæ" being applied to this portion of the cerebellum. The gray matter is found mostly in this situation, but it is also found in the interior of the cerebellum in one large mass called the corpus dentatum and in two much smaller collections. The white matter of the cerebellum is situated in the interior and the fibres are arranged mostly in three groups. One, composed of fibres which come from the cerebrum and are distributed to the gray matter of the cerebellum; a second consists of fibres which connect together the two hemispheres of the cerebellum; and a third group, which is composed of fibres passing downward and connecting the cerebellum with the medulla oblongata. These groups of fibres are known respectively as the superior, the middle, and the inferior peduncles of the cerebellum. Besides these three main groups of white fibres there are other more scattered fibres, some of which connect together the two hemispheres while others serve to connect different parts in the same hemisphere.

The Medulla Oblongata.

The medulla oblongata, though merely the upper expanded portion of the spinal cord, is always described as a portion of the brain or encephalon, and consists of white matter situated mostly upon the outside and gray matter mostly located in the interior. The medulla lies within the skull, and is received into the fissure between the two hemispheres of the cerebellum upon its under surface. It is of pyramidal shape with base upward, and measures an inch and a quarter in length, three quarters of an inch in breadth at its widest part, and half an inch in thickness. The surface of the medulla is marked in front by a shallow longitudinal median fissure and behind by a deep longitudinal fissure, also in the median line, which divides it thus into halves, a right and a left, each half being again divided into four columns by means of other smaller longitudinal grooves. These fissures and grooves and columns are continuous with those existing in the spinal cord.

Beginning in front, the column upon either side and next to the anterior median fissure is the anterior pyramid. The innermost fibres (those nearest to the median fissure) of this anterior pyramid split up into four or five bundles which decussate—that is, pass across from one side to the other of the median fissure. These decussating fibres come from the lateral columns of the spinal cord. The greater portion of the fibres making up the anterior pyramids do not decussate, but pass directly upward. These non-decussating fibres in the anterior pyramid are derived from the anterior column of the spinal cord. Just to the outside of the anterior pyramid is another column of white fibres, called the lateral tract, which tract is continuous with the lateral column of the cord. The lateral tract is displaced above by the bulging forward of a collection of gray matter in the medulla oblongata, called the olivary body. This olivary body, composed of gray matter in the interior, is covered upon the outside by a layer of white substance.

Following the medulla around to its posterior or hind side, we come next to the column called the restiform body. This is continuous with the posterior column of the spinal cord, and as it ascends it diverges from its fellow of the opposite side to make room for the space known as the fourth ventricle.

The Posterior Pyramid.

Farther back, and lying between the restiform body and the posterior median fissure of the medulla oblongata, upon each side, is another column, the posterior pyramid. This column is continuous with the posterior median column of the cord. At first the two pyramids lie close together, being separated only by the posterior median fissure. As they ascend they diverge to allow for the fourth ventricle, and farther up they merge into the restiform bodies just mentioned. The fourth ventricle is one of the ventricles of the brain, and is connected with the two lateral ventricles and with the third ventricle by means of the Y-shaped passage already referred to as the foramen of Monro. The fourth ventricle is continuous also with the central canal of the spinal cord, of which it represents an expansion. By the diverging of the restiform bodies and of the posterior pyramid, the fourth ventricle is open above, and when the cerebellum has been removed the interior of the ventricle is exposed to view, and its "floor" is seen to be composed of gray matter. This gray matter upon the floor of the fourth ventricle contains nerve-cells which give origin to many of the cranial nerves. Besides the gray matter forming the olivary body and the floor of the fourth ventricle, the medulla oblongata contains a few other small masses of gray nuclei.

The pons Varolii (Fig. 42) is composed almost entirely of white nerve-fibres, some transverse and others longitudinal, and these fibres connect together the various parts of the brain already mentioned — viz., the

cerebrum above, the medulla oblongata below, and behind the cerebellum. It is situated between the crura of the cerebrum above and the medulla oblongata below, and lies between the hemispheres of the cerebellum. Upon its under surface, which is seen when we look at the base of the brain, appear transverse fibres, and situated more deeply within the pons is another band of transverse fibres. These transverse bands, superficial and deep, connect together the two hemispheres of the cerebellum. The longitudinal fibres come mostly from the cord through the medulla, but a few originate in the olivary body of the medulla, and a few others come from the small scattered masses of gray matter situated in the pons itself.

The Pons Varolii.

The spinal cord is that portion of the cerebro-spinal axis which is contained within the canal formed by the posterior branched portions of the vertebræ. The cord is about seventeen and a half inches long, and in weight bears the relation to the encephalon of 1 to 33. It does not fill the calibre of the canal by a considerable margin, the space left around the cord and its membranes being filled with a loose fibrous tissue which prevents injury to the cord during motions of the spine; nor does it fill the entire length of the spinal canal, but extends from the first cervical vertebra to the lower border of the first lumbar, a distance of two thirds of the length of the spinal canal, and terminates below in a slender filament composed mostly of gray matter. It consists of white matter situated upon the outside and of gray matter placed in the interior. In the cervical region and in the upper lumbar region the cord presents enlargements which correspond to those regions of the cord from which are given off the large nerve branches to the upper and lower extremities (Fig. 44). Upon the anterior and the posterior surfaces of the cord are seen in the median line longitudinal fissures. These are the anterior median fissure, which is wide but shallow, and the posterior, which is narrow but deep. Upon either side of the anterior median fissure is the antero-lateral fissure, which corresponds

The Spinal Cord.

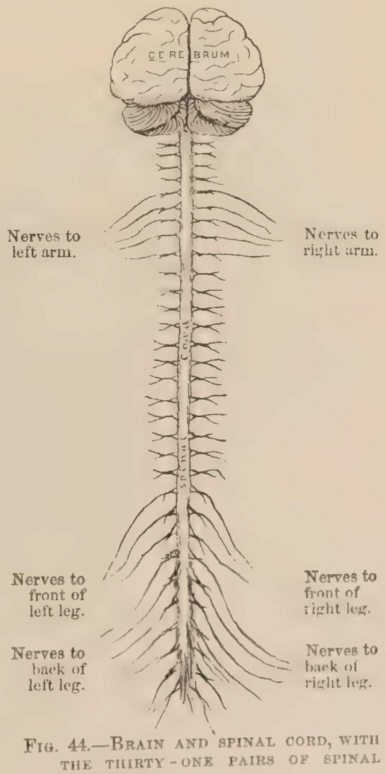

Fig. 44.—Brain and spinal cord, with the thirty-one pairs of spinal nerves.

to the rows of minute foramina or holes from which the anterior roots of the spinal nerves emerge from the cord. Upon either side of the posterior median fissure is a slight groove, the postero-lateral fissure, from which emerge the posterior roots of the spinal nerves. The cord is divided into lateral halves by the anterior and posterior median fissures; and by the antero-lateral and postero-lateral fissures each half is again divided into three columns, named from in front the anterior, the lateral, and the posterior columns of the cord. These columns are further divided by anatomists according to the source and destination of the nerve-fibres which they contain in their various parts. The gray matter of the cord is situated in its interior in the shape of two crescents which are joined together across the median line by a commissure of gray matter. In this commissure is situated the central canal of the cord.

From the spinal cord arise the thirty-one pairs of spinal nerves, and each nerve arises by two roots. One, the posterior or larger, is the sensory root, and comes from the gray matter of the cord emerging from the cord through the postero-lateral fissure; the other, the anterior or smaller root, is the motor root of the nerve, and is attached to the white matter of the anterior columns of the cord. Within the cord the fibres composing both roots pass through the white matter into the gray matter of the spinal cord, where they spread out, passing, some upward, some downward, and some across to the opposite side of the cord.

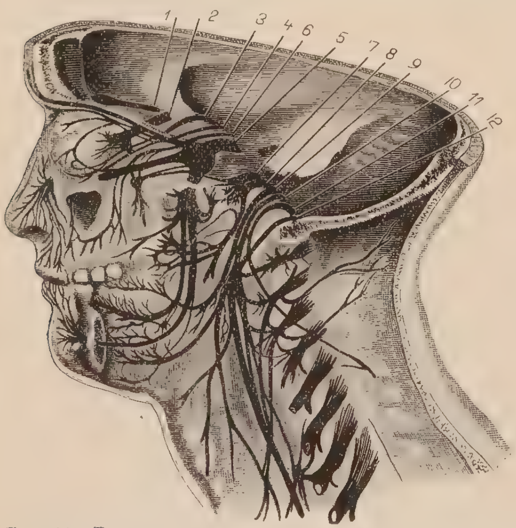

Fig. 45.—Diagram showing the relative position of the cranial and upper spinal nerves as they emerge through their foramina.

1, the olfactory nerve; 2, the optic; 3, oculo-motor; 4, the trochlear; 5, the trifacial; 6, the abducent ocular; 7, and 8, the facial and auditory; 9, the glosso-pharyngeal; 10, the pneumogastric; 11, the spinal accessory; 12, the hypoglossal.

The spinal cord, like the brain, is inclosed by three membranes: the dura mater, situated externally, the pia mater, lying in close contact with the cord, and between them the arachnoid membrane. The dura mater of the cord differs from that inclosing the encephalon in that it does not come in contact with the bony arches of the vertebræ, but is separated from them by a considerable interval filled with loose fatty tissue, and also in that it does not send partitions into the fissures of the cord.

The cranial nerves are those nerves which, arising from the cerebro-spinal centre, pass out through openings in the base of the skull (Fig. 45).

The Cranial Nerves. They are known by special names, and are also numbered, beginning in front, according to the order in which they emerge from the base of the encephalon. They are as follows:

NUMBER.		NAME.	FUNCTION.
First pair.......	Right and left	olfactory nerves..........	Special sense.
Second pair.....	" "	optic nerves..............	Special sense.
Third pair......	" "	motor oculi nerves........	Motion.
Fourth pair.....	" "	pathetic nerves...........	Motion.
Fifth pair.......	" "	trifacial nerves...........	Common sensation. Motion. Special sense.
Sixth pair.......	" "	abducens nerves..........	Motion.
Seventh pair....	" "	facial nerves	Motion.
Eighth pair.....	" "	auditory nerves...........	Special sense.
Ninth pair......	" "	glosso-pharyngeal nerves..	Common sensation. Special sense.
Tenth pair......	" "	pneumogastric nerves.....	Motion. Sensation.
Eleventh pair ...	" "	spinal accessory nerves....	Motion. Sensation.
Twelfth pair....	" "	hypoglossal nerves........	Motion.

The first cranial or olfactory nerve is the special nerve of the sense of smell, and it is really a prolonged process of brain substance ending in a bulb. This process arises from the brain by three roots, and lies upon the under surface of the frontal lobe. From the bulbous end are given off about twenty nerve filaments which pass through holes in that part of the roof of the nose cavity formed by the ethmoid bone. These nerve filaments are distributed to the mucous membrane lining the upper portion of the nasal cavities.

The second, or optic nerve, is the special nerve of the sense of sight, arising on each side from two roots which form at first the optic tracts. These tracts, after winding around the crura cerebri, join in the median line, and from this junction, known as the optic commissure, the optic nerves proper arise. The optic nerves pass out from the cavity of the skull into the orbits through holes known as the optic foramina. Each nerve then pierces the coats of the eyeball at a point upon the back side of the eye a little to the inner side of the middle, and is distributed to the retina.

The third cranial nerve, or the motor oculi, the fourth or pathetic, and the sixth nerve, or abducens, are the motor nerves of the eyeball, and are distributed to the muscles which move it. They pass from the

cavity of the cranium into the orbit through a large opening known as the sphenoidal fissure.

The fifth, or trifacial nerve, is most largely the nerve of common sensation of the head and face, but also supplies some of the muscles of the lower jaw with motor fibres, and through a branch distributed to the tongue it is probably a nerve of the special sense of taste. The fifth nerve is similar to a spinal nerve in that it arises by two roots, one sensory and one motor, and in that the sensory root has developed upon it a small mass of gray matter known as a ganglion. The two roots emerge from the side of the pons Varolii and pass forward, the sensory root ending in the ganglion above mentioned. This ganglion then gives off three large branches: the ophthalmic or first division of the fifth nerve, the superior maxillary or second division of the fifth nerve, and the third branch, which joins the motor root that has passed beneath the ganglion to form the inferior maxillary or third division of the fifth nerve.

The first division, or ophthalmic nerve, soon divides into three branches, which pass from the cavity of the cranium through the sphenoidal fissure into the orbit, where they subdivide into branches which supply the eyeball, the lachrymal gland, the exposed mucous covering of the eye, the mucous membrane of a part of the nasal cavity, and the muscles and skin of the eyebrow, forehead, and nose, all with common sensation. The second division of the fifth nerve, the superior maxillary nerve, passes through a small round hole in the base of the skull, and after running forward through the substance of the upper jawbone appears upon the face below the eye. The branches of this nerve supply the upper teeth, a portion of the throat, and the side and front of the face with common sensation. The third division of the fifth nerve is called the inferior maxillary division, and it is a mixed nerve composed of both sensory and motor fibres. Its branches supply the lower teeth, the outer ear, the lower part of the face, and the muscles of mastication all with sensation. Some of its branches supply a few of the muscles of mastication with motor impulses, and the lingual or gustatory branch of this inferior maxillary nerve is distributed to the mucous membrane lining the tongue and may have to do with the sense of taste.

The seventh cranial nerve is known as the facial. It arises in the groove between the olivary and the restiform bodies at the lower border of the pons Varolii. It emerges from the cavity of the skull after passing through that portion of the temporal bone which forms part of the base of the skull and contains the organs of hearing. The canal in the temporal bone through which the facial nerve runs is a crooked one, and being of bone, is unyielding; hence inflammation of the nerve or of the bone will the more readily cause pressure upon the nerve and will result

in its paralysis. The nerve makes its exit from the skull at a point behind the outer ear and divides into many branches which spread out over the head and face and upper portion of the neck and supply all the muscles of expression with motor impulses. Through motor impulses supplied by some of its branches it assists in swallowing and in hearing.

The eighth cranial nerve is the special nerve of the sense of hearing, and is called the auditory nerve. It arises from the groove between the olivary and restiform bodies at the lower border of the pons, and enters the substance of the conical portion of the temporal bone through the same opening as the facial nerve, but does not again emerge, for it is distributed to the organ of hearing contained within the temporal.

The ninth pair of cranial nerves, the glosso-pharyngeal, arises by two or three filaments from the upper portion of the medulla oblongata in the groove between the olivary and restiform bodies. Each nerve emerges from a rather large opening in the base of the skull, known as the jugular foramen, at which point the nerve presents two swellings caused by small masses of gray matter and called ganglia. The nerve passes downward behind the jaw and supplies the mucous membrane covering the throat and tonsil with ordinary sensation, and is distributed to the mucous membrane of the tongue as the special nerve of the sense of taste.

The tenth pair of cranial nerves is composed of the right and left pneumogastric or vagus nerves. Each vagus arises by eight or ten filaments from the medulla between the olivary and restiform bodies. It emerges from the skull through the jugular foramen and passes down through the neck, lying close to the carotid vessels, into the cavity of the chest. The nerve upon the right side runs down upon the back or posterior surface of the lung, the œsophagus, and the stomach, while upon the left side it descends behind the left lung and then comes to the front, its branches covering the anterior surface of the œsophagus and stomach. The branches of the pneumogastric are many, and they supply the organs of voice and hearing with both motor and sensory filaments; and to the pharynx, œsophagus, stomach, and heart they supply motor fibres. It will thus be seen how much wider distribution have the branches of the vagus than those of any other cranial nerve.

The eleventh, or spinal accessory, is composed of two portions: one, which joins the pneumogastric and is known as the accessory portion, arises by five filaments from the lateral tract of the cord just below the roots of the vagus, while the other portion, known as the spinal portion, arises by filaments from the lateral tract of the cord as low down as the sixth cervical vertebra. The accessory portion soon joins the vagus and is distributed with it. The spinal portion passes through the jugular

foramen down into the neck, and supplies two of the muscles of the neck with filaments.

The twelfth, or hypoglossal nerve, arises by a dozen filaments from the groove between the pyramidal and olivary bodies in a line with the anterior roots of the spinal nerves. Each nerve passes from the skull through an opening just in front of the kidney-shaped surface upon the occipital bone. The nerve courses downward, dividing into branches, and supplies the tongue with its motor impulses.

The origins of the cranial nerves given above are those known as superficial. The nerve-roots have nearly all been traced deeply within the gray matter of the brain and their real beginnings located, but to describe them properly would call for a closer and more thorough description of the brain than can be given here.

The Spinal Nerves.

The spinal nerves are arranged in thirty-one pairs, and after being formed by the junction of the anterior or motor roots with the posterior or sensory roots, they emerge from the spinal canal through openings between the pedicles of the vertebræ. A spinal nerve is thus seen to contain both motor and sensory fibres. Upon the sensory roots of the spinal nerves small masses of gray matter, called ganglia, are formed. Each spinal nerve, after passing from the spinal canal, divides into two divisions—an anterior and a posterior. The posterior division is usually small, and divides up into smaller branches which supply the back portion of the neck and body. The anterior divisions of the nerves are larger than the posterior, for they supply the main portion of the body and give rise to the large nerve-trunks which supply the extremities.

The spinal nerves have received names from the regions of the spine in which they emerge, and are further known by numbers in each region, counting from above. Thus there are eight pairs of cervical nerves, each pair consisting of a right and a left nerve. The first cervical nerve emerges from the spinal canal between the occipital bone and the first cervical vertebra, while the eighth cervical nerve passes out between the last or seventh cervical vertebra and the first dorsal vertebra. There are twelve dorsal nerves, five lumbar, five sacral, and but one coccygeal nerve upon each side of the body. The anterior divisions of the upper four cervical nerves communicate freely with one another, and thus form what is known as the cervical plexus, and the branches from this plexus are distributed to the muscles and skin on the back of the head and neck and over the back of the shoulder, and one long branch, the phrenic, passes down and is distributed to the diaphragm, and constitutes the motor nerve of that muscle. The anterior divisions of the four lower cervical nerves are remarkable for their large size, and they communicate in a network of branches with one another and with the first dorsal nerve, forming in

this manner the brachial plexus. From this brachial plexus are given off the large nerve trunks which pass into and supply the upper extremity. The largest of these are the ulnar, upon the inner side; the median, occupying the middle of the extremity; and the musculo-spiral nerve, which winds around the back of the arm and gives off the radial nerve on the outer side of the forearm. The ulnar nerve, as it passes from the arm into the forearm, lies behind the elbow joint and to its inner side, and is frequently hit by blows or falls upon the elbow. Such a contusion of the ulnar nerve gives rise to the peculiar tingling sensation in the lower arm and fingers, and is the cause of that sensation which is experienced when the "funny bone" or "crazy bone" is injured.

The anterior divisions of the dorsal nerves form the twelve intercostal nerves, which pass forward in the spaces between the ribs and supply the walls of the chest and upper abdomen. There being but eleven intercostal spaces, the last intercostal nerve runs along the lower border of the twelfth rib.

The anterior divisions of the four upper lumbar nerves form the lumbar plexus, and from this plexus many nerve-trunks arise, most of which pass downward to the lower extremity, being distributed largely upon its anterior side. The largest of these trunks is the anterior crural nerve, which, as it passes from the abdomen into the lower extremity, lies to the outer side of the femoral artery.

The sacral plexus is formed by the anterior divisions of the fifth lumbar nerve and of the four upper sacral nerves. The largest branch of this plexus is the great sciatic nerve, the largest nerve of the body. This nerve passes backward across the buttock and downward into the thigh, running behind the knee into the leg.

The Sympathetic Nervous System.

The motor nerves of the cerebro-spinal system may be said to control the movements of the voluntary muscles. The involuntary muscles, which are found in the heart and in the coats of the blood-vessels and of the hollow viscera, such as the stomach and intestines, are controlled by another system of nerve-centres and nerve-fibres, and this system is the sympathetic nervous system (Fig. 46). The nerve-centres or ganglia of this system are not collected together into one mass, as in the cerebro-spinal system, but are widely distributed throughout the head and trunk, and are arranged largely in a series of pairs extending along the side of the vertebral column, as follows:

In the neck or cervical	region	....	3 pairs of ganglia.
" chest or dorsal	"	....	12 " "
" loin or lumbar	"	....	4 " "
" sacral	"	....	5 " "
" coccygeal	"	....	1 ganglion.

Besides this series of ganglia there are three large aggregations of ganglia and nerve-fibres, known as ganglionic plexuses. These are situated respectively in the chest, in the belly, and in the pelvis, and are known as the thoracic plexus, the abdominal or solar plexus, and the pelvic or hypogastric plexus. There are, further, sympathetic ganglia connected with the fifth cranial nerves in the head, and additional scattered ganglia in the great cavities of the body.

The nerves arising from these centres or ganglia are of two varieties—viz., nerves of communication and nerves of distribution. The branches of communication connect with one another the various ganglia, and also connect the ganglia with the nerves of the cerebro-spinal system, which in turn send branches to the sympathetic ganglia. The branches of distribution, by their frequent communications, form plexuses which surround and follow the blood-vessels, and they are distributed to the involuntary muscular fibres situated in the coats of the blood-vessels and hollow viscera and in the secreting cells.

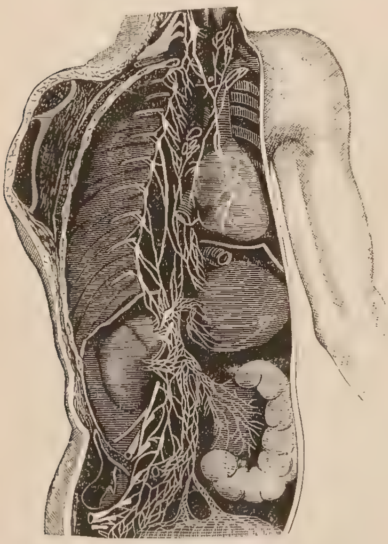

Fig. 46.—The sympathetic or ganglionic nervous system.

The branches of the three cervical ganglia of the sympathetic supply the vessels and glands in the neck, the pharynx, the larynx, and through a collection of ganglia and nerves, known as the cardiac plexus, they supply also the heart. In the abdomen the branches of the solar plexus divide and communicate to form many secondary plexuses which supply the various abdominal organs, including the hollow viscera, and thus we have a renal plexus, a gastric plexus, a hepatic plexus, etc. Lower down the hypogastric plexus divides into two pelvic plexuses, branches from which are distributed upon the various pelvic organs, and there is a vesical plexus for the bladder, a prostatic plexus for the prostate gland, a uterine plexus for the uterus, etc. In addition to the branches and plexuses just mentioned, plexuses with their branches accompany all the blood-vessels throughout the head, the trunk, and the upper and lower extremities, so that the whole body is supplied with nerves of the sympathetic system.

SECTION VII.

THE ALIMENTARY CANAL.

The alimentary canal is an irregularly shaped tube, which begins at the lips and ends at the anus. It is about thirty feet long, and is lined throughout with mucous membrane. It includes the mouth, the pharynx, the œsophagus, the stomach, the small intestine, and the large intestine. (See *Physiology: The Vital Processes in Health*, Fig. 2.)

The mouth is guarded in front by the lips, and at the sides is limited by the cheeks, and behind it opens into the pharynx. The roof of the mouth is formed in front by the hard palate and behind by the soft

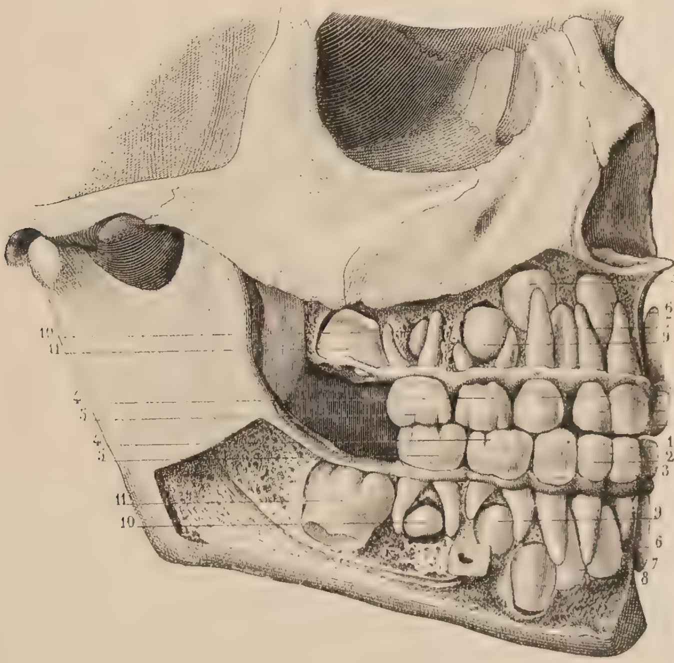

FIG. 47.—TEMPORARY AND PERMANENT TEETH. (Sappey.)

1, 1, temporary central incisors; 2, 2, temporary lateral incisors; 3, 3, temporary canines; 4, 4, temporary anterior molars; 5, 5, temporary posterior molars; 6, 6, permanent central incisors; 7, 7, permanent lateral incisors; 8, 8, permanent canines; 9, 9, permanent first bicuspids; 10, 10, permanent second bicuspids; 11, 11, first molars.

palate, which is drawn up during the act of swallowing, so as to shut off the pharynx from the nasal cavities. From the middle of the soft palate hangs the uvula.

In the mouth are the teeth, and man is furnished during his life with two sets—one set for childhood and a second for adult life (Fig. 47).

The teeth of childhood, called the temporary or milk teeth, are twenty in number, ten for each jaw—viz., four incisors or cutting teeth, situated in front; back of these upon each side one canine or tearing tooth; and still farther back, two molars or grinding teeth, upon each side. The temporary teeth appear as follows:

The Teeth.

Seventh month, the central incisors.

Seventh to tenth month, the lateral incisors.

Twelfth to fourteenth month, the anterior molars.

Fourteenth to twentieth month, canine.

Eighteenth to thirty-sixth month, posterior molars.

The teeth of the lower jaw make their appearance somewhat before those of the upper jaw.

The permanent teeth are thirty-two in number, sixteen for each jaw: in front four incisors; behind these, upon each side, one canine; farther back, upon each side, two bicuspids; and still farther back, upon each side, three molars. Of these teeth, the incisors, the canine, and the bicuspids correspond in position to the teeth of the temporary set, while the permanent molars occupy a new portion of the jaw, which has developed as the result of growth. The teeth of the permanent set appear at the following periods:

Six and a half years, first molars ("six-year molars").

Seventh year, central incisors.

Eighth year, lateral incisors.

Ninth year, first bicuspids.

Tenth year, second bicuspids.

Eleventh to twelfth year, canine.

Twelfth to thirteenth year, second molars.

Seventeenth to twenty-first year, third molars ("wisdom teeth").

The teeth of the lower jaw appear before those of the upper. Upon each side of the opening from the mouth to the pharynx is found the tonsil, a gland of rounded form.

The mouth is supplied with moisture by mucous glands situated everywhere in its mucous-membrane lining, and the first of the digestive fluids with which the food comes in contact is also poured into the mouth. This is the saliva, and it is secreted by six salivary glands, three upon each side (Fig. 48): the parotid gland, situated around and below the ear; the submaxillary gland, situated under the jaw, near its angle; and the sublingual gland, which lies under the tongue near the front. It is the inflammation and swelling of the parotid gland that is known as "mumps."

Saliva and Salivary Glands.

The pharynx is the dilated portion of the swallowing tube which lies

behind the nasal cavities, the mouth, and the upper portion of the windpipe or larynx. It is made up of muscle, and is lined with mucous membrane. Upon each side above opens the Eustachian tube, which connects the cavity of the middle ear with the mouth and hence with the outer world. Below, the pharynx opens and merges into the œsophagus.

The Pharynx and Œsophagus.

The œsophagus or gullet is the canal which leads from the pharynx above downward into the stomach below. It thus has to pass through the chest cavity, and, perforating the diaphragm, enters the belly cavity and connects with the stomach. It is nine inches long and is made up largely of muscular tissue of the involuntary variety, and it is lined with mucous membrane. The point of its smallest calibre is where it pierces the diaphragm, as may be seen by referring to Fig. 24, *c*. Its course is somewhat curved, but its general direction is downward, backward, and to the left.

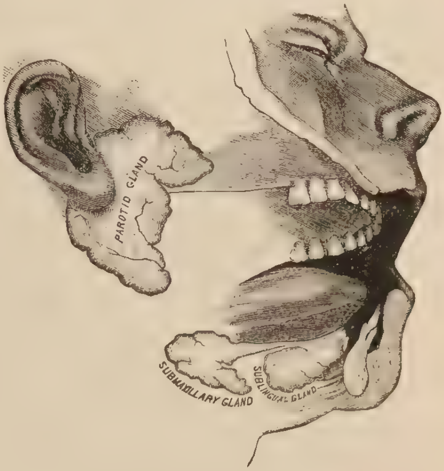

Fig. 48.—Salivary glands. (Tracy.)

The Abdomen.

The abdomen (Fig. 49) is the largest cavity of the body, and extends from the diaphragm above to the bottom of the pelvic cavity below. But the term "abdomen," as usually employed, is limited to the large portion of the general cavity situated above the pelvis. The abdomen is limited behind by the vertebræ and lower ribs, and is surrounded and inclosed by its muscular walls. The abdomen proper contains the following organs or viscera: Of digestion, the lower end of the œsophagus, the stomach, the small intestine, the large intestine (except its lower end, known as the rectum), the liver and gall bladder, and the pancreas; of secretion, the kidneys with their ureters, and, when distended, the urinary bladder; of circulation and absorption, the aorta and inferior vena cava and their branches, the lymphatic vessels and glands, with the beginning of the thoracic duct; and the spleen, besides many nerves. The pelvis contains in the male the rectum and bladder; and in the female also the vagina, uterus, and ovaries.

The inner membranous lining of the abdomen is the peritonæum, and it may be roughly described as forming a closed sac divided into two compartments, the greater and the lesser peritoneal cavities. Into this sac bulge the various abdominal organs, some to such an extent as to be

almost completely enveloped by the peritonæum, others only being covered in front by the membrane. The peritonæum lines the walls of the abdomen and also many of the viscera, and in many cases it forms folds which hold the viscus or organ in place. A large fold of peritonæum passes down in front of the intestines from the lower border of the stomach, forming the great omentum or apron, and contains much fat within its layers. The peritonæum is a serous membrane, and as all serous cavities have a direct and intimate connection with the lymphatic system, they readily absorb bacterial poisons and are prone to serious inflammation when exposed to infection.

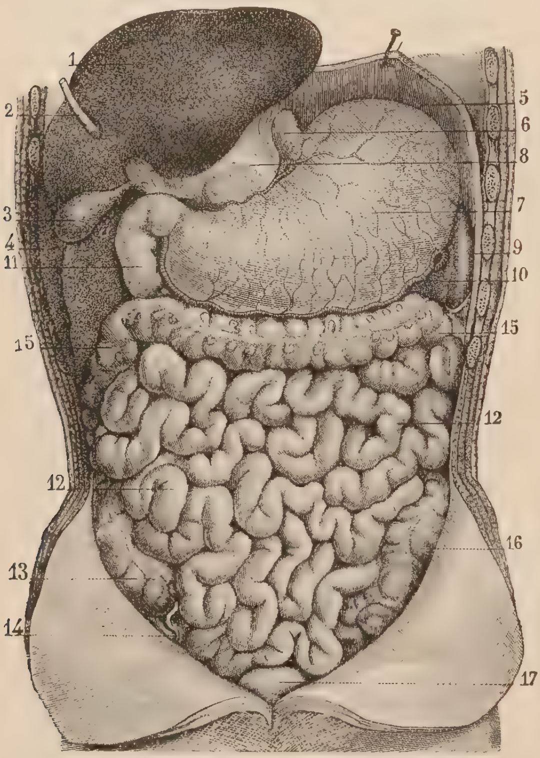

Fig. 49.—Position of abdominal contents.

1, inferior surface of the liver; 2, round ligament of the liver; 3, gall bladder; 4, superior surface of the right lobe of the liver; 5, diaphragm; 6, lower portion of the œsophagus; 7, stomach; 8, gastro-hepatic omentum; 9, spleen; 10, gastro-splenic omentum; 11, duodenum; 12, 12, small intestine; 13, cæcum; 14, appendix vermiformis; 15, 15, transverse colon; 16, sigmoid flexure of the colon; 17, urinary bladder.

The Stomach.

The stomach (Fig. 50) is a dilated portion of the alimentary canal, measuring, when moderately distended, twelve inches by four. It lies in the upper left and middle region of the abdomen. The œsophagus opens freely into the stomach on its upper border and near to its left extremity. This is called the cardiac opening because of its nearness to the heart, being separated from that organ only by the diaphragm. At the right or pyloric end of the stomach is the opening into the small intestine. This opening into the small intestine is guarded by a circular valve known as the pyloric valve.

The stomach is made up of four coats: (1) Serous, external, and derived from the peritonæum; (2) muscular, consisting of unstriped or in-

A DISSECTION OF THE HUMAN BODY
Showing the Principal Organs and Vessels in the Abdominal and Thoracic Cavities.

voluntary muscular fibres arranged in layers and running in all directions; (3) areolar, composed of loose tissue in which pass the vessels; and (4) mucous, internal. This mucous membrane lines the cavity of the stomach, and when the stomach is empty it is thrown into numerous longitudinal folds. Imbedded in the mucous membrane are the gastric follicles, of which there are two varieties, differing in structure and in the substance they secrete. These are (1) the pyloric glands, named from being most numerous in the neighbourhood of the pylorus, which secrete a substance something like mucus; and (2) the peptic glands, found all over the stomach, which secrete the gastric juice.

The Small Intestine.

The small intestine is a tube something over twenty feet in length, which extends, with many curves, from the stomach to the beginning of the large intestine. The first ten inches of the small gut is somewhat larger than the rest of it, and it is known as the duodenum. It is curved like a horseshoe, and into the concavity of the curve is placed the large end or head of the pancreas. Into the lumen of the duodenum, at about its middle, empties the common bile and pancreatic duct. The upper two fifths of the rest of the small intestine is known as the jejunum, and the lower three fifths is the ileum. The ileum joins with the big gut in the lower right region of the abdomen.

Fig. 50.—The stomach.

The small intestine is composed of four coats: (1) Serous, from the peritonæum; (2) muscular, consisting of involuntary fibres running in two directions, lengthwise and crosswise around the gut; (3) areolar, containing the vessels; and (4) the mucous coat, which contains muscular fibres, vessels, and glands. The mucous membrane is thrown into numerous folds, which run crosswise, and from its surface project a great number of very small club-shaped processes each containing the beginning of a lacteal vessel, and whose function is absorption. Scattered through the whole small intestine are the glands, and in the ileum these occur in groups or aggregations known as *Peyer's patches*. In typhoid fever these patches are inflamed and ulcerated.

The large intestine extends from the ileum to the anus, and is about five feet long. It is much larger than the small intestine, and is largest at its commencement, where it is called the cæcum. The large intestine is divided into regions of which there are three—viz., the cæcum, the colon, and the rectum. The cæcum is the large pouch which constitutes

the commencement of the big gut, and it measures two and a quarter by three inches in diameter. Connected with the lower and back part of the cæcum is a narrow, wormlike tube, the *vermiform appendix.* This in some of the lower animals is very large and adds to the size of the cæcum, but in many animals, including man, it has become rudimentary and shows a tendency to disappear gradually in the process of evolution. Opening into the inner side of the large intestine, at the point where the cæcum becomes colon, is seen the ileum. This opening is protected by a valve which allows matter to pass from the small intestine into the large, but prevents more or less completely its return from the large intestine into the ileum. This is the ileo-cæcal valve.

The Large Intestine.

The colon is divided according to the direction in which it passes into four regions—viz. : (1) Ascending colon, which passes up along the right side of the abdomen, lying nearer to the back than the front, until it reaches the under surface of the liver, when it makes a turn nearly at right angles and becomes the (2) transverse colon. The transverse colon passes across the body below the stomach, and upon the left side near the spleen it curves downward and becomes the (3) descending colon. The descending colon passes down until the left innominate bone is reached, at which point the large gut becomes sinuously curved and is called the (4) sigmoid flexure.

The last section of the large intestine and of the alimentary canal is the rectum. The rectum is from six to eight inches long, and extends from the sigmoid flexure above to the anal opening below. The rectum, as in the other portions of the gastro-intestinal tract, has the four coats. The serous coat, however, does not cover the lower portion of the viscus, and the muscular coat is especially well developed. Just above the anus the rectum is considerably dilated. The direction of the rectum from the anal opening is upward and backward at first and then it passes to the left side. The mucous membrane of the rectum is in transverse folds, and these are sometimes very large and will interfere with the passage of an instrument into the rectum. The anal opening is guarded and controlled by two sets of circular muscular fibres, known respectively as the external and internal sphincters. The blood-vessels of the rectum are the hæmorrhoidal arteries and veins, and the veins frequently become dilated and varicose and give rise to the condition known as hæmorrhoids or piles.

SECTION VIII.

THE LIVER, PANCREAS, AND SPLEEN.

THE LIVER.

Size, Location, and Functions.

The liver is the largest gland in the body, and is situated in the upper right and mid regions of the abdomen, lying mostly under the ribs of the right side, and weighs about four pounds in the healthy adult. Its longest diameter lies across the body, and is about twelve inches; from behind forward its diameter is something over six inches. It is thickest through upon its right side, where it measures about three inches, and it thins out as it extends toward the left so as to present a thin edge. It has two functions—the secretion of the bile and the production of peculiar chemical changes in certain of the constituents of the blood brought to it through the portal circulation. The latter action is the glycogenic function.

Fissures, Lobes, and Ligaments.

The upper surface, smooth and rounded, is covered by peritonæum and divided by a fissure into two lobes, the right being much larger than the left. This surface is in contact with the diaphragm. The under surface (Fig. 51) is somewhat hollowed out, and is divided by a broad fissure into two large lobes, a right and a left. Between the right and left lobes are four other fissures, such as the fissure for the gall bladder, fissure for the inferior vena cava, etc., which subdivide this portion of the liver into three other lobes. The under surface of the liver is covered with peritonæum, and is in contact with the stomach, the duodenum, the colon, where it makes a turn from ascending to transverse, and with the right kidney. The liver is held in place by five ligaments, four of which, however, are not ligamentous, being merely folds of the peritonæum.

Vessels.

The vessels of the liver are, like the fissures, lobes, and ligaments, five in number—viz.: (1) The hepatic artery and (2) the portal vein, which convey the blood to the liver, the former from the heart and the latter from the gastro-intestinal tract; (3) the hepatic veins, which convey the blood from the liver and which empty into the inferior vena cava. There are three large hepatic veins and many smaller ones. (4) The hepatic duct, which is formed by the many ducts within the liver and which conveys the bile from the liver; and (5) the lymphatic vessels, which are numerous and distributed freely throughout the liver. The liver substance is made up of liver cells, which give the appearance of honeycomb when the liver is seen through a microscope.

These liver cells are of rounded variety, but are rendered many-sided by being so crowded together. They vary in size from $\frac{1}{1000}$ to $\frac{1}{2000}$ of an inch in diameter. These liver cells are the bile-secreting element of the liver, and they are surrounded by a close network of small blood-vessels and by the beginnings of the hepatic duct.

The Gall Bladder.

The gall bladder is a pear-shaped membranous bag in which the bile is stored when not needed immediately in the intestine. It holds something more than a fluidounce. It lies upon the under surface of the liver with its head or fundus directed forward, while its opening is directed backward. It is lined with mucous membrane.

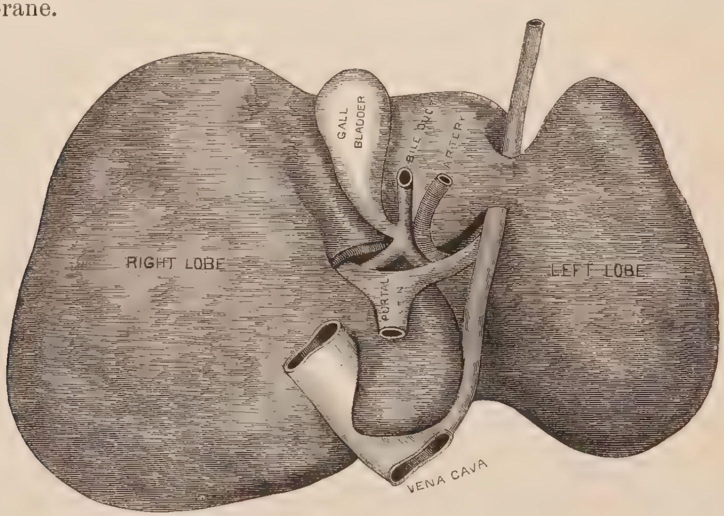

FIG. 51.—UNDER SURFACE OF THE LIVER, SHOWING THE GALL BLADDER AND A SECTION OF BLOOD-VESSELS.

Ducts.

The ducts by which the bile passes from the liver are three in number: (1) The hepatic duct, which is formed by the junction of two trunks into which have been collected all the many smaller ducts of the liver. This hepatic duct is about an inch and a half long, and unites with (2) the cystic duct, which is small and about one inch in length. By this junction the hepatic and cystic ducts form (3) the common bile duct. This common bile duct is about three inches long and empties into the duodenum near its middle, joining just at the point of entry with the pancreatic duct.

THE PANCREAS.

The pancreas (Fig. 52) is a gland similar in structure to the salivary glands, and is shaped like a dog's tongue, having at its right extremity a broad end called the "head" of the pancreas, and tapering toward the

left to a point that forms the "tail" of the pancreas. The term "body" is applied to that portion of gland lying between these two ends. The pancreas is soft and loose in texture, and is not inclosed by a surrounding capsule. In sheep and cattle it constitutes the "sweetbreads" of the market.

Structure, Location, and Function.

The pancreas lies in the upper middle and left portion of the abdomen, and measures about seven inches in length by an inch and a half

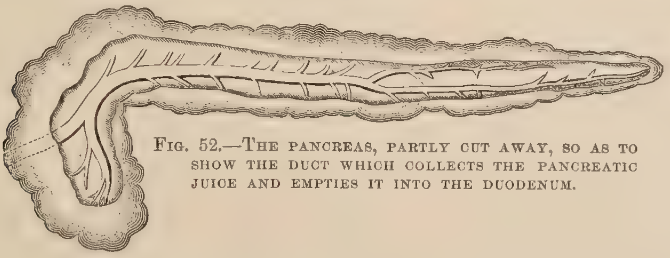

FIG. 52.—THE PANCREAS, PARTLY CUT AWAY, SO AS TO SHOW THE DUCT WHICH COLLECTS THE PANCREATIC JUICE AND EMPTIES IT INTO THE DUODENUM.

in breadth and three quarters of an inch in thickness. The pancreas weighs about three ounces. Running from left to right through the gland is the pancreatic duct, which, receiving branches in its course, gradually increases in size. After leaving the head of the pancreas the duct opens into the middle of the duodenum, usually joining with the common bile duct at the point of entry.

The function of the pancreas is to secrete the pancreatic juice, one of the five digestive fluids.

THE SPLEEN.

The spleen is usually described as a "ductless" gland, because it possesses no canal through which its secretion can be conveyed. It is of flattened oval shape and somewhat curved, so as to present a hollowed-out surface toward the stomach, to the left of which it lies. The spleen is dark-red in colour, contains many and large blood-vessels, and is of a brittle consistence. It is situated in the upper left region of the abdominal cavity, and when small lies under the lower ribs of the left side. The spleen is five inches long, four inches wide, and in thickness it measures about an inch, and weighs about seven ounces. It is relatively much larger in an infant than in the adult, and as a result of malarious poison sometimes becomes enormously enlarged. It is always larger after a full meal than during fasting.

Structure, Size, and Weight.

The spleen is supposed to have to do with the formation of blood-corpuscles, and also to have some office connected with the digestion or assimilation of food. Persons from whom it has been removed do not, however, seem to suffer any great inconvenience.

SECTION IX.

THE THORAX.

The thorax (Figs. 8 and 9) is the name applied to the framework, composed partly of bone and partly of soft tissues, which incloses the cavity of the chest known as the thoracic cavity. The walls of the thorax are made up in part by the sternum and upper six costal cartilages in front, at the side by the ribs, and behind by the ribs and dorsal vertebræ; and in part by the muscles and fascia which are attached to these structures.

Cavity of the Thorax.

The cavity of the thorax is narrow above, and the opening into the neck is small. In its lower part the thoracic cavity is wider, because of the increased length of the ribs and the bulging forward of the sternum or breast bone, and also because of the curve backward of the spinal column in the dorsal region. Below, the cavity of the thorax is limited by the diaphragm, and on account of the oblique position occupied by this muscle, which is attached in front to the sternum at the level of the sixth and seventh costal cartilages, and behind to the last or twelfth rib, the chest cavity is much deeper behind than it is in front. It is also much wider from side to side than from before backward.

Besides vessels and nerves and glands, the thorax contains the heart, inclosed in its sac, the pericardium, and the lungs, inclosed by the pleural membranes. The heart, with its pericardium and the position it occupies within the chest, has already been described on a preceding page of this article.

SECTION X.

THE ORGANS OF VOICE AND RESPIRATION.

As in describing the gastro-intestinal tract we began at the lips and followed the canal downward through its course, in describing the lungs we shall begin with the larynx and windpipe and follow them into the chest, where are located the lungs.

The Larynx.

The larynx is the upper dilated portion of the windpipe, and is especially adapted to include the vocal cords and the muscular mechanism which moves them (Fig. 53). The air-passages from the trachea to the lips, inclusive, represent the pipe of an organ, and as there is only one pipe, the production of the different sounds is made possible by an elaboration of detail; thus the vocal cords

by which the air is caused to vibrate to produce the sound can be rendered lax or very tense, and the size of the space through which the air passes can also be rendered large or small. (See *Physiology: The Vital Processes in Health*, Fig. 22, *A*, *B*.)

The larynx is, then, the organ of voice, and is made up of a number of pieces of cartilage joined together by ligaments in such a way that considerable motion between them can take place (Figs. 54, 55). There are nine of these cartilages: three single—the thyroid, the cricoid, and the epiglottis; and six in three pairs—two arytænoid, two cornicula laryngis, and two cuneiform. The cornicula laryngis and cuneiform cartilages are very small. The epiglottis is shaped like a leaf, and is attached by the stem to the thyroid cartilage in the median line in front. During breathing the epiglottis maintains an upright position, but during the act of swallowing it closes down over the opening of the larynx, and thus prevents the entrance of food into the air-passages. The thyroid cartilage is composed of a right and a left side which unite in front, forming the "Adam's apple," which can be seen and felt beneath the skin in front of the throat. The thyroid cartilage forms the side and front of the greater portion of the larynx, and to the middle of its interior surface are attached the front extremities of the vocal cords. The arytænoid are two triangular-shaped cartilages placed at the back of the larynx and separated by an interval. To these cartilages are attached the posterior or rear end of the vocal cords. The cricoid cartilage is the foundation structure of the larynx, to which the thyroid and arytænoid cartilages are attached and upon which they move. It is shaped like a signet ring with its expanded side placed posteriorly. It is attached below to the first ring of the trachea. The interior of the larynx is lined with mucous membrane. The true vocal cords pass from behind forward from the arytænoid to the thyroid cartilage, and have between them a narrow fissure known as the glottis;

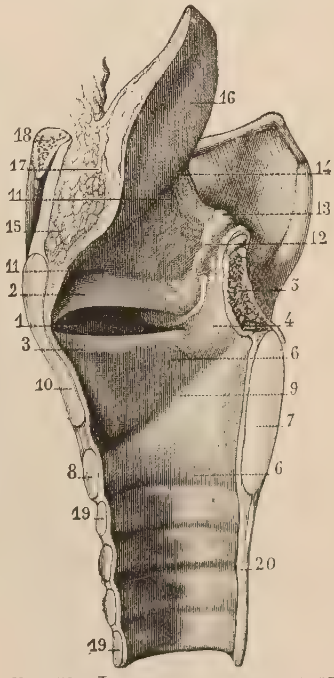

Fig. 53.—Longitudinal section of the human larynx, showing the vocal cords. (Sappey.)

1, ventricle of the larynx; 2, superior vocal cord; 3, inferior vocal cord; 4, arytænoid cartilage; 5, section of the arytænoid muscle; 6, 6, inferior portion of the cavity of the larynx; 7, section of the posterior portion of the cricoid cartilage; 8, section of the anterior portion of the cricoid cartilage; 9, superior border of the cricoid cartilage; 10, section of the thyroid cartilage; 11, 11, superior portion of the cavity of the larynx; 12, 13, arytænoid gland; 14, 16, epiglottis; 15, 17, adipose tissue; 18, section of the hyoid bone; 19, 19, 20, trachea.

and above the true vocal cords are two folds of mucous membrane known as the false vocal cords.

The Trachea. The trachea or windpipe is a tube four and a half inches long, which extends from the larynx downward to divide into the two bronchi. (See *Physiology: The Vital Processes in Health*, Fig. 9.) It is not quite cylindrical in shape, for it is flattened in the rear. It is nearly an inch in diameter from side to side, and is composed of about twenty incomplete rings of cartilage held together by a fibrous membrane containing a few muscular fibres. All of these rings are incomplete behind where the tube is completed by fibrous membrane. The trachea behind lies in contact with the œsophagus and divides below into a right and a left bronchus for the right and left lung respectively.

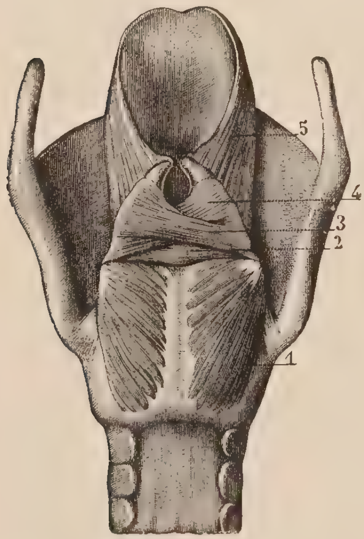

Fig. 54.—Posterior view of the muscles of the larynx. (Sappey.)

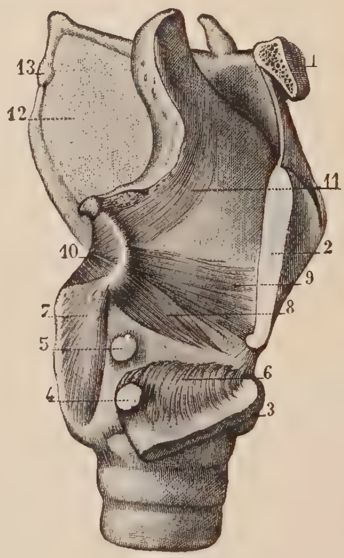

Fig. 55.—Lateral view of the muscles of the larynx. (Sappey.)

Fig. 54.—1, posterior crico-arytænoid muscle; 2, 3, 4, different fasciculi of the arytænoid muscle 5, arytæno-epiglottidean muscle.

Fig. 55.—1, body of the hyoid bone; 2, vertical section of the thyroid cartilage; 3, horizontal section of the thyroid cartilage, turned downward to show the deep attachment of the crico-thyroid muscle; 4, facet of articulation of the small cornu of the thyroid cartilage with the cricoid cartilage; 5, facet on the cricoid cartilage; 6, superior attachment of the crico-thyroid muscle; 7, posterior crico-arytænoid muscle; 8, lateral crico-arytænoid muscle; 9, thyro-arytænoid muscle; 10, arytænoid muscle; 11, arytæno-epiglottidean muscle; 12, middle thyro-hyoid ligament; 13, lateral thyro-hyoid ligament.

These two bronchi subdivide many times, until finally they become very small and enter into the formation of the lungs themselves.

The lungs are the organs of respiration, and form the bellows which forces the air through the larynx and makes possible the production of sound. There is a right and a left lung, and between them nestle the heart and the large blood-vessels (Fig. 56). Each lung is cone-shaped,

with the apex upward at the root of the neck, and the base downward in contact with the diaphragm. Each lung is divided into lobes, the left having two and the right having three lobes. The lungs are light pink in colour and are of a spongy texture. Because of the air contained within them, the lungs will float in water. The weight of both lungs taken together is about forty-two ounces. When

The Lungs.

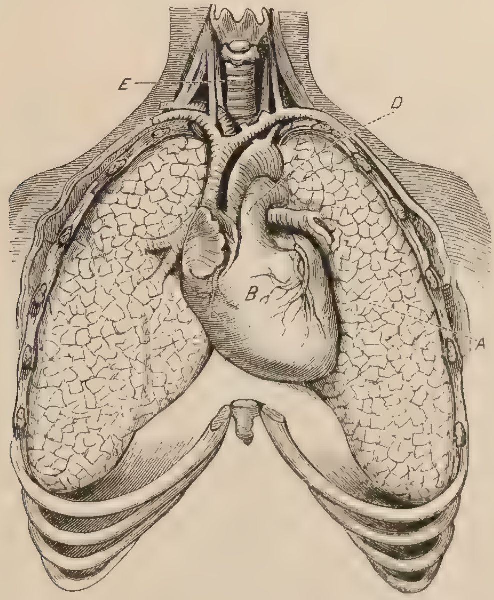

FIG. 56.—SHOWING THE RELATIVE POSITION OF HEART AND LUNGS IN THE CAVITY OF THE CHEST. *A*, left lung; *B*, heart; *D*, pulmonary artery; *E*, trachea, or windpipe.

lung tissue is examined under the microscope it is found to be composed of many-sided cells varying from $\frac{1}{70}$ to $\frac{1}{200}$ of an inch in diameter, and having very thin walls. These are the air-cells, and they are found grouped around and opening into the smallest division of the bronchial tube. Lying closely around these air-cells are plexuses of the pulmonary capillaries, the walls of which are also very thin, and it is here that the interchange of substances takes place between the pure air that has been breathed into the lungs and the impure blood brought to the lungs through the pulmonary artery. The inner surface of the chest wall and the lungs and pericardium, and also the large vessels in part, are covered by a serous membrane called the pleura. The pleura, as is the case with the peritonæum in the abdomen, forms a closed sac—the pleural sac or cavity. Inflammation of the pleura is known as *pleurisy*.

Bearing an anatomical relation with the air-passages, but having no direct functional relation with respiration, are two ductless glands (Fig.

57). One of them lies upon the front and side of the lower portion of the larynx and upper portion of the trachea, and is known as the thyroid gland. When this gland is enlarged it may be readily seen and felt, and gives rise to the condition known as goître. When this gland becomes functionally inactive peculiar changes take place in the body, resulting in the disease known as myxœdema. The other of these two ductless glands is the

The Thyroid and Thymus Glands.

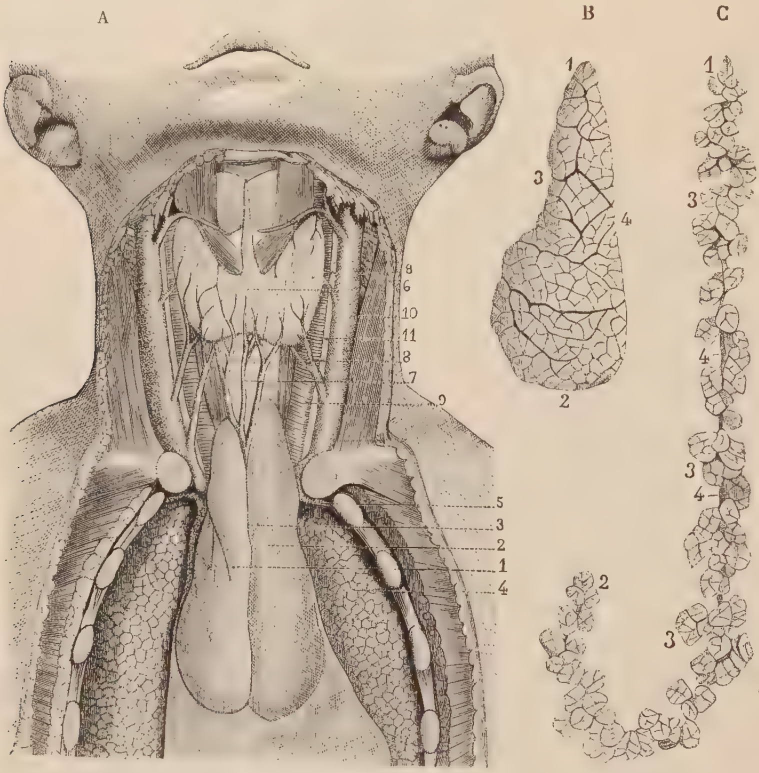

FIG. 57.—THYROID AND THYMUS GLANDS. (Sappey.)

A. 1, right lobe of the thymus; 2, left lobe; 3, groove between the two lobes; 4, lungs, the anterior borders raised to show the thymus; 5, terminal branch of the internal mammary vein; 6, thyroid gland; 7, median inferior thyroid veins; 8, lateral inferior thyroid veins; 9, common carotid artery; 10, internal jugular vein; 11, pneumogastric nerve. B. Right lobe of the thymus with the investing membrane removed. 1, upper extremity of the lobe; 2, lower extremity; 3, external border; 4, internal border. C. Arrangement of the lobules of the same lobe, around the central cord. 1, upper extremity of the lobe; 2, lower extremity; 3, 3, 3, lobules; 4, 4, central cord.

thymus, which lies upon the front and sides of the lower trachea. This gland is much larger in the infant than in the adult.

SECTION XI.

THE URINARY ORGANS.

The Kidneys.

The two kidneys, a right and a left, are placed in the back part of the abdomen in the region of the loins, and are separated from one another by the bodies of the twelfth dorsal and the first and second lumbar vertebræ. The right kidney is somewhat lower than the left. The kidneys are outside of the peritoneal cavity, their front surfaces only being partly covered by peritonæum. Each kidney is about four inches long by two inches wide and one inch in thickness. The kidney weighs about five ounces. Its front and back surfaces are flattened, its outer edge is rounded, and its inner somewhat hollowed out. (See *Physiology : The Vital Processes in Health*, Fig. 12.) This hollowed-out space is occupied by the dilated commencement of the duct leading from the kidney to the bladder. This duct is the ureter, and the upper dilated portion is known as the pelvis of the kidney. The kidney is made up essentially of small bodies called Malpighian bodies, and of small and large tubes leading from them into the pelvis of the kidney. Malpighian bodies are composed of a tuft of capillary blood-vessels inclosed in a sac, which is the beginning of a small tube or tubule. The tubules curve and twist upon themselves in a complicated manner, and are surrounded by a network of veins. It is at these two places—the Malpighian bodies and the venus plexus surrounding the tubules—that the fluid and solid ingredients leave the blood. After a circuitous course the tubes open into the pelvis of the kidney.

Ureters and Suprarenal Capsules.

The ureters are the ducts of the kidney, and they begin above at the pelvis of the kidney and pass downward and slightly inward into the pelvis to reach the bladder upon its rear surface. They enter the bladder near its lower portion. The ureters are about seventeen inches long and are about the size of a goose-quill. Lying above each kidney is another of the "ductless" glands of the body. They are the suprarenal capsules.

The Bladder.

The bladder, the reservoir of the urine, is contained within the cavity of the pelvis, but when it is much distended it rises up into the abdomen proper, and occasionally reaches as high as the umbilicus. In the male the bladder lies directly in front of the rectum, but in the female the vagina lies between the rectum and the bladder. The capacity of the female bladder is something more than the male, though when empty the male is the larger. The bladder is covered above and behind by peritonæum, but there is a small space in

front, close to the bone of the pelvis, which is outside of the peritoneal cavity, where the bladder may be tapped without danger of injury to the peritonæum. The bladder is held in place by five true ligaments and by five folds of peritonæum, called false ligaments. One of the true ligaments is a cord which extends from the top of the bladder to the umbilicus. This is the urachus, and it is the obliterated remains of a large duct which in the embryo connects the cavity of the bladder with a sac outside the body, called the allantois.

The bladder is composed of three coats: (1) The serous coat from the peritonæum, which only partially covers the bladder; (2) the muscular coat, composed of three layers of unstriped muscular fibres; and (3) the mucous coat, which forms the mucous membrane lining the bladder.

The Urethra.

The canal leading from the bladder to the body surface is called the urethra. In the male the urethra is about nine inches long and is divided into three main portions: (1) The prostatic portion, next to the bladder, the widest portion of the canal, is about an inch and a quarter in length, and lies within the prostate gland; (2) the membranous portion, the narrow part of the canal, is about three quarters of an inch in length; (3) the spongy or penile portion of the urethra is about six inches long. Just behind the outer opening or meatus the urethra is dilated into a pouch which is called the fossa navicularis.

The average size of the male urethra is three eighths of an inch. In the female the urethra is only an inch and a half in length, and opens outwardly just in front and above the opening into the vagina.

SECTION XII.

THE ORGANS OF SPECIAL SENSE.

There are five organs of special sense—namely: the tongue, the seat of the sense of taste; the nose, of the sense of smell; the eye, wherein resides the sense of sight; the ear, the organ of hearing; and the skin, in which resides the organs of the sense of touch.

The Tongue.

The tongue, the organ of the special sense of taste, occupies the floor of the mouth, and is composed almost entirely of muscle. The base or root of the tongue is at the back and is attached to the small U-shaped bone—the hyoid bone. To this bone is attached some of the muscles of the pharynx, and from it the larynx is suspended by a fibrous membrane. The tip of the tongue looks forward and lies just behind the lower incisor teeth and is freely movable. The

back or dorsum of the tongue is usually convex, but may be made to assume a deeply concave appearance. The mucous membrane of the tongue is richly supplied with papillæ, which are elevations containing minute branches of capillary vessels and many small nerve-fibres. They are covered by a layer of protecting cells called epithelium or epithelial cells. These papillæ are of three sizes. The largest, from eight to ten in number, occupy the back of the dorsum and are arranged in two lines, which are directed backward and inward and join to form a V; the medium-sized papillæ occupy the sides and apex of the tongue, while upon the forward two thirds of the dorsum are distributed the papillæ of smallest size. In the papillæ of large and medium size are found the so-called "taste-goblets."

The Nose.

The nose is the organ of the special sense of smell, and is composed of two portions, one external and projecting—the nose; and the other contained within the skull—the nasal fossæ or cavities. (See *Physiology: The Vital Processes in Health*, Figs. 43 and 44.) The whole organ is divided into two compartments, a right and a left, by a median partition called the sæptum.

The prominent, projecting portion of the organ of smell, commonly called the nose, is formed in small part by the nasal bones of the face, but chiefly of five pieces of cartilage, two on each side and one forming the sæptum. The nose is lined inside with mucous membrane and covered upon the outside by integument, and just within the openings of the nose, or the nostrils, are a number of hairs.

Nasal Cavities.

The main portion of the organ of smell is formed by the nasal cavities or fossæ. These open in front into the nose by openings called the anterior nares, and behind into the upper pharynx by the posterior nares. They have projecting into their outer walls the turbinated bones, and are divided by a sæptum made up mostly of the vomer bone. Each fossa has opening into its outer wall a chamber, which exists in the interior of the superior maxillary bone, called the antrum of Highmore. Opening into the upper part of each fossa is the canal leading from the eye, which conducts the tears into the nose when the secretion of this fluid is not excessive. The nasal fossæ are lined with mucous membrane, and to the upper part of this are distributed the branches of the olfactory nerve—the nerve of the special sense of smell. The mucous membrane of the lower portion of the nose is supplied with nerves of ordinary sensation only, and is designated as the respiratory portion of the nose.

The eyes are the organs of sight, and they are contained within the orbits, which are cavities formed by the bones of the head and face for the reception of the eyeballs. Seven bones enter into the formation of each orbit—three of the head and four of the face. The three of the

head are the frontal, the sphenoid, and the ethmoid. They are single bones, and each assists in forming both orbits. The four bones of the face are the superior maxillary, the malar, the lachrymal, and the palate—all pairing bones. The orbits are irregularly cone-shaped, with their apices directed backward and somewhat inward, and their bases forward and somewhat outward. At the apex of the orbit is an opening called the optic foramen, through which the optic nerve and the artery of the eye enter from the cavity of the skull. There are other openings into the orbits for the transmission of nerves and vessels.

The Eyes and their Orbits.

The eyeball is situated in the forward part of the orbit and is imbedded in a mass of fat, being immediately surrounded by a serous membrane to allow of the movements of the eyeball (Fig. 58).

The Eyeball.

Section through the eyeball (see *Physiology: The Vital Processes in Health*, Fig. 33) shows it to be composed of the union of the segments of two spheres of different size. The posterior larger segment comprises about five sixths of the globe, while the anterior smaller segment, repre-

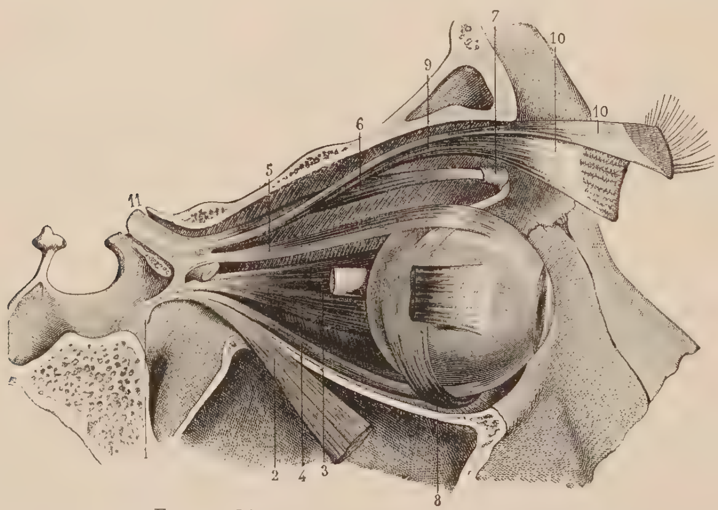

FIG. 58.—MUSCLES OF THE EYEBALL. (Sappey.)
1, attachment of the tendon connected with the inferior rectus, internal rectus, and external rectus; 2, external rectus, divided and turned downward, to expose the inferior rectus; 3, internal rectus; 4, inferior rectus; 5, superior rectus; 6, superior oblique; 7, pulley and reflected portion of the superior oblique; 8, inferior oblique; 9, levator palpebri superioris; 10, 10, middle portion of the levator palpebri superioris; 11, optic nerve.

sented by the transparent cornea, forms about one sixth of the ball of the eye. The eye is about one inch in diameter, being slightly less in its antero-posterior diameter than in the others.

The globe of the eye is composed of several coverings, containing

within their interior various refracting media called humours (Fig. 59). The coverings or tunics are in three layers: the external, composed of the sclerotic and the cornea; the middle, composed of the choroid, iris, and ciliary processes; and the internal, composed of the retina alone. The refracting humours contained within the ball are also three in number: aqueous, crystalline lens, and the vitreous body.

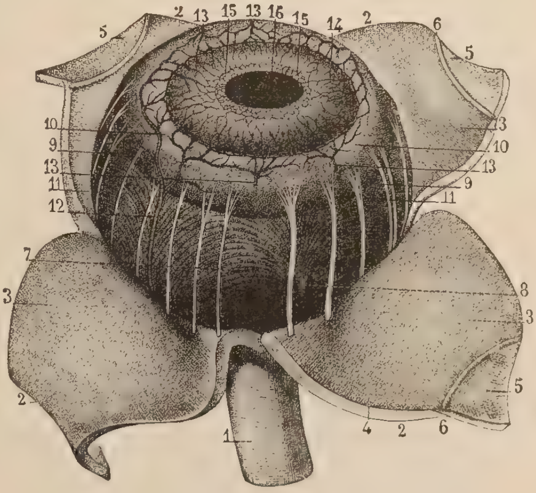

FIG. 59.—CHOROID COAT OF THE EYE. (Sappey.)
1, optic nerve; 2, 2, 2, 2, 3, 3, 3, 4, sclerotic coat, divided and turned back to show the choroid; 5, 5, 5, 5, the cornea, divided into four portions and turned back; 6, 6, canal of Schlemm; 7, external surface of the choroid, traversed by the ciliary nerves and one of the long ciliary arteries; 8, central vessel, into which open the vasa vorticosa; 9, 9, 10, 10, choroid zone; 11, 11, ciliary nerves; 12, long ciliary artery; 13, 13, 13, 13. anterior ciliary arteries; 14, iris; 15, 15, vascular circle of the iris; 16, pupil.

The sclerotic coat is a dense opaque, fibrous structure which forms the outer tunic of the posterior five sixths of the eye, and gives to the ball its shape and firmness. The sclerotic is hid within the eye socket, and it is pierced behind by the optic nerve. The outer surface of the sclerotic is of a white colour. The outer tunic is formed in front by the cornea to the extent of one sixth of the globe. The cornea forms the segment of a smaller sphere than is represented by the rest of the ball, and hence projects slightly forward. This curve of the cornea is more marked in early life and becomes less as age advances.

The second covering of the eyeball is formed in the posterior five sixths by the choroid, which is a thin, chocolate-coloured membrane containing many blood-vessels. The choroid is also perforated behind by the optic nerve. The choroid is wanting in front, and around this circular opening thus left the edges of the choroid are frilled, and these frills are the ciliary processes. They lie behind and are hid by the iris. The iris is a circular muscular curtain which nearly completes the choroid in the anterior sixth of the eye. It has a round opening in its centre, the pupil, which varies in size according to the action of the muscular fibres of which the iris is composed. The muscular fibres are of the involuntary variety, and they are arranged in two sets—one set of circular fibres, which, by their contraction, render the pupil smaller; and the other, composed of radiating fibres, which, by their contraction, dilate the pupil.

The retina is the most internal of the tunics of the eye. It is a membrane of soft consistence and is transparent. It is thicker behind than in front, and directly in front it is wanting altogether. The retina receives the expansion of the optic-nerve fibres and is sensitive to light. At the point where the optic nerve enters the retina the latter is insensitive to light, and this is known as the "blind spot." This blind spot is situated just to the inner side of another spot which is the most sensitive part of the retina, and which occupies the central position of the retina. This is called the "yellow spot."

There are two cavities within the eye—one in front, just behind the cornea, and the other behind, larger, and occupying the greater portion of the globe. These two cavities are separated by the crystalline lens.

The anterior of these two cavities contains a few drops of a watery fluid called the aqueous humour. The back chamber contains the vitreous humour or body. This vitreous body is of the consistence of jelly, and, like the aqueous humour, it is perfectly transparent.

The crystalline lens is double convex in shape, is composed of many layers of transparent fibrous material, and it is inclosed by a transparent capsule.

The Lachrymal Gland and Canals.

Situated outside of the eyeball, at the outer angle of the orbit, is a small gland which secretes the tears. This is the lachrymal gland. At the inner angle of the eye in front, and beneath the skin, are two small ducts, the lachrymal canals. These soon open into a larger canal, the nasal duct. These ducts convey the tears from around the front of the cornea downward into the nasal cavity, and it is only when there is an excessive secretion of the tear fluid, or when, as in some cases, the ducts become occluded, that the lachrymal fluid overflows upon the cheek.

The ear is the organ of hearing, and it is composed of three portions: external, middle, and internal (Fig. 60). See also *Physiology: The Vital Processes in Health*, Figs. 39, 40, 41, and 42.

External Ear.

The external ear consists of two portions: one, much expanded, the pinna, which appears upon the side of the head, and is composed of a cartilage frame and is covered by skin; and the other portion a canal leading from the pinna to the middle ear. This canal, the auditory, consists of a cartilaginous portion and of a bony portion, the latter contained within the temporal bone. The entire canal is something over an inch long, and is lined throughout with skin. At the bottom of the auditory canal is the drum of the ear.

The middle ear or tympanum is a cavity hollowed out in the interior of the temporal bone, measuring a little less than half an inch from before backward and about a quarter of an inch from side to side and from above downward. It is shut off from the external ear by the

membrana tympani or ear drum. The middle ear is filled with air, and connects with the outer world through the Eustachian tube, which extends from the tympanum to the pharynx. Other openings exist in the walls of the tympanum for the transmission of nerves, arteries and veins, and muscles. Behind are also seen the openings into the mastoid cells which are contained in the temporal bone, and are connected with the middle ear.

Middle Ear.

The membrana tympani is a thin, translucent membrane which separates the external from the middle ear. It presents externally a slightly convex surface, which is due to the attachment to its inner surface of one of the little bones of the ear —viz., the malleus. The vibrations of the ear drum are transmitted to the internal ear by a chain of three bones, named, from their shape, the malleus or mallet, the incus or anvil, and the stapes or stirrup.

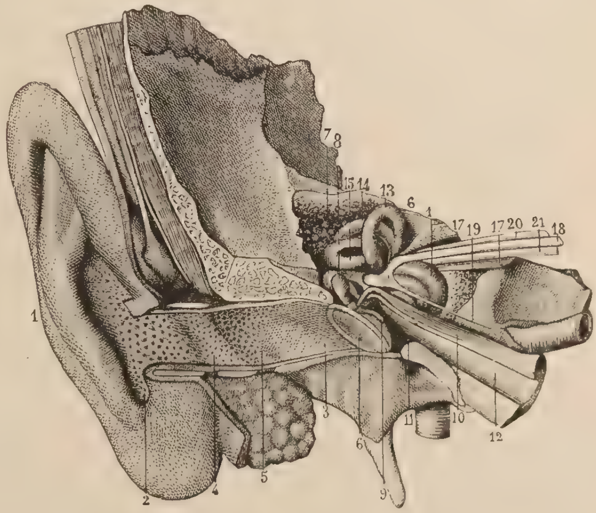

FIG. 60.—GENERAL VIEW OF THE ORGAN OF HEARING. (Sappey.) 1, pinna; 2, cavity of the concha, on the walls of which are seen the orifices of a great number of sebaceous glands; 3, external auditory meatus; 4, angular projection formed by the union of the anterior portion of the concha with the posterior wall of the auditory canal; 5, openings of the ceruminous glands, the most internal of which form a curved line which corresponds with the beginning of the osseous portion of the external meatus; 6, membrana tympani and the elastic fibrous membrane which forms its border; 7, anterior portion of the incus; 8, malleus; 9, handle of the malleus, applied to the internal surface of the membrana tympani, which it draws inward toward the projection of the promontory; 10, tensor tympani muscle, the tendon of which is reflected at a right angle, to become attached to the superior portion of the handle of the malleus; 11, tympanic cavity; 12, Eustachian tube, the internal, or pharyngeal extremity of which has been removed by a section perpendicular to its curve; 13, superior semicircular canal; 14, posterior semicircular canal; 15, external semicircular canal; 16, cochlea; 17, internal auditory canal; 18, facial nerve; 19, large petrosal branch, given off from the ganglioform enlargement of the facial and passing below the cochlea, to go to its distribution; 20, vestibular branch of the auditory nerve; 21, cochlear branch of the auditory nerve.

The internal ear or labyrinth contains the expansion of the auditory nerve, and consists of a series of canals and cavities in the substance of the temporal bone. The labyrinth is divided into three parts: (1) the vestibule, (2) the semicircular canals, (3) the cochlea. The vestibule forms the central cavity of the internal ear, and to its outer wall is attached the base of the stapes or stirrup bone, the last of the chain of three, the first of which, the malleus, is attached to the membrana tympani. The semicircular canals are three in

Internal Ear.

number, and they are located above and behind the vestibule, into which they open. The three semicircular canals are so arranged that each canal is at right angles to the other two, and hence they all occupy different planes. The cochlea, shaped like a snail-shell, is placed in front of the vestibule and connects with it. The spiral canal of the cochlea takes two and a half turns around a "central axis," and is divided into two by a spiral sæptum which follows the windings of the canal.

The entire internal ear is lined with a serous membrane called the membranous labyrinth.

SECTION XIII.

THE SKIN.

The skin forms a protecting investment for the entire outer surface of the body, and is the principal seat of the sense of touch, having distributed to it the endings of the sensitive nerves. The skin is also an excretory organ, and to a limited extent it possesses the power of absorption. (See *Physiology: The Vital Processes in Health*, Fig. 13.)

The skin is composed of two layers. The external layer or epidermis, also known as the cuticle or scarf skin, is composed of hardened epithelial cells, and acts as a protective covering for the more sensitive true skin beneath. In places the epidermis is especially thick, as in the palms of the hands and upon the soles of the feet.

The Hair and Nails.

The nails and the hair belong to the epidermis, and are but modifications and elaborations of it. The nails are firmly adherent to the true skin. The hair exists in nearly every part of the surface of the body; the roots of the hair are contained in "hair follicles," and they project into the true skin, and where they are very long, as upon the scalp, the roots extend through the skin into the connective tissue beneath.

The deep layer of the skin is the cutis, the corium, or the true skin. The average thickness of this layer is about one twelfth of an inch.

Sebaceous and Sweat Glands.

Imbedded in the corium are the sebaceous glands, which are more numerous in the skin of the face than elsewhere. These glands open by small ducts upon the surface of the skin. When the ducts become clogged they give rise to the condition known as "black heads," and if the blocking up of the ducts is complete, "wens" will be developed.

Also imbedded in the corium are the sweat glands. These are most numerous upon the palm of the hand, where they number as many as 2,800 to the square inch.

SECTION XIV.

EMBRYOLOGY.

The whole human body is developed from an egg or ovum, the product of the female; but this egg must first have been fertilized by a spermatozoön, which comes only from the male. Every time menstruation occurs an ovum escapes from one of the ovaries of the woman and passes into the corresponding Fallopian tube which leads from the ovary of that side into the cavity of the womb or uterus. This passage through the length of the Fallopian tube probably requires about a week of time. If the ovum does not become fertilized it may come away from the uterus toward the end of the menstrual flow, though there is much reason to believe that it remains in the uterus for a considerable length of time. Under these conditions, however, the ovum does not develop, but passes from the uterus or is destroyed.

The Egg or Ovum.

The ovum (see *Physiology: The Vital Processes in Health*, Fig. 47) is an egg composed of yolk only, and has the structure of a simple cell. It is $\frac{1}{125}$ of an inch in diameter, and is surrounded by a transparent envelope known as the *vitelline membrane.* The yolk itself, or the vitellus, is situated within this membrane, and it is composed of granules of various sizes imbedded in a thick fluid. Within the yolk or vitellus of the egg, but not occupying the centre of the egg, is a spherical membrane filled with a thin fluid. This is the nucleus of the cell, or the germinal vesicle of the ovum, and it measures about $\frac{1}{600}$ of an inch in diameter. Situated upon that side of the germinal vesicle nearest to the periphery of the vitellus is a yellowish spot about $\frac{1}{4000}$ of an inch in diameter, which is named the nucleolus of the cell, or the germinal spot of the ovum.

The other of the two sexual elements essential at the very beginning for the production of a new human body is the spermatozoön. This cell, as has already been said, is the product of the male, and the spermatozoa are contained in great numbers in the seminal fluid. A spermatozoön (see *Physiology: The Vital Processes in Health*, Fig. 49) is an elongated cell with its nucleus at one end forming a "head" and with the body of the cell drawn out into a "tail." This tail has the power of a wavy motion, and causes the whole cell to travel along quite rapidly, so that a moving spermatozoön very much resembles a minute tadpole.

The Spermatozoön.

The union of the spermatozoön with the ovum takes place in the upper part of the Fallopian tube, and consists of the bodily entrance of a

spermatozoön through the vitelline membrane into the substance of the vitellus or yolk. The tail disappears and the head only remains, and it becomes a part of the fertilized or impregnated ovum.

Fecundation.

By the time this ovum so fertilized has reached the cavity of the uterus, which it does at the end of the first week, the first change to make its appearance as the result of the impregnation has been completed. This is the "segmentation" of the ovum, and is a process of cleavage by which the substance of the ovum becomes divided, first into two masses, then into four, then into eight, then sixteen, and so on until

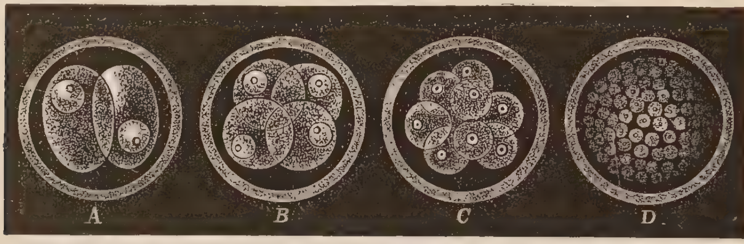

FIG. 61.—SEGMENTATION OF THE VITELLUS. (Haeckel.)
A, the vitellus divided into two cells; B, the two cells divided into four; C, the four cells divided into eight; D, the blastodermic cells.

the ovum becomes a mass of nucleated cells, called "vitelline spheres" (Fig. 61). This segmentation takes place within the vitelline membrane, and the spheres become arranged into two groups, an inner and an outer, forming together a membrane called the blastodermic membrane. As the arrangement comes to be more definite the outer group of cells or spheres forms a complete lining to the inner surface of the vitelline membrane, while the inner group of cells forms a disk which lines a small portion of the internal surface of the outer layer. The outer layer of this blastodermic membrane is known as the *epiblast*, and the inner layer as the *hypoblast.* That area of the blastodermic membrane which is composed of two layers, the epiblast and the hypoblast, is known as the germinal area. The impregnated ovum, unlike the unfertilized ovum, remains in the uterus and continues to grow, and takes an attachment to the lining membrane of the womb. During the second week the first trace of the embryo appears as a faint streak at the posterior end of the germinal area; this is known as the primitive trace (Fig. 62). The embryo is the fœtus or unborn child, and the term is usually limited to the very early stages. The next event in the development of the embryo is the formation of a distinct layer of cells between the epiblast and the hypoblast, so that the blastodermic membrane, instead of being composed of only two layers, is now divided into three. This new layer, situated between the epiblast on the outside and the hypoblast on the inner side, is the *mesoblast.*

From the various layers of this blastodermic membrane are developed all the organs that go to make up the completed human body, and, besides, they form a number of structures which belong to fœtal life, and which are of no further use when they have performed some temporary function.

From the epiblast are ultimately developed the epidermis of the body, with the superficial glands, such as the breasts, the brain and spinal cord and their nerves, and portions of the eye, nose, and ear.

From the hypoblast are formed the epithelial cell linings of the gastro-intestinal tract, of the glands connected with it, and of the respiratory organs.

The remaining portions of the body are formed from the mesoblast, and include the true skin, the blood-vessels, the voluntary and involuntary muscles, the kidneys, etc., together with the general connective-tissue framework of the whole body.

At the same time that the blastodermic membrane is dividing into three layers, instead of remaining composed of two, by this formation of the mesoblast, changes are taking place at the situation of the primitive trace. The primitive trace itself disappears; but commencing in front and extending backward in a line with that occupied by the primitive trace, the cells of the epiblastic layer of that portion of the blastodermic membrane which constitutes the germinal area become heaped up in two longitudinal ridges, presenting between them a groove. This heaping up continues until the ridges become lateral plates which meet behind, thus transforming the groove into a canal. This is the neural canal, and from the epiblast which lines it are developed the brain and spinal cord and their nerves. The front portion of the canal becomes dilated and curved upon itself to accommodate the mass of nerve-centres which go to make up the brain.

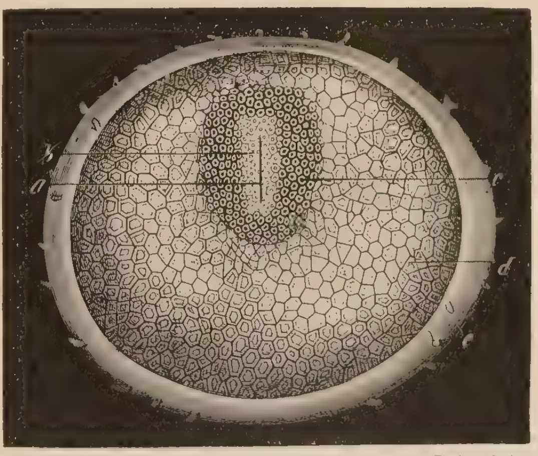

FIG. 62.—PRIMITIVE TRACE OF THE EMBRYON. (Liégeois.)

a, primitive trace; *b*, area pellucida; *c*, area opaca; *d*, blastodermic cells; *e*, *e*, villi beginning to appear on the vitelline membrane.*

The further tracing of the growth of the embryo into the fully developed child becomes too complicated, and requires too much detail to be

included in a work of this size and scope, and nothing further than this small beginning will be attempted. Some further details of the subject are found in the article in this volume upon *Physiology: The Vital Processes in Health*, and for a complete history of the events which take place at this early period of life the reader is referred to special works upon the subject.

II.

PHYSIOLOGY: THE VITAL PROCESSES IN HEALTH.

By FREDERIC S. LEE, Ph. D.

INTRODUCTION.

The physiology of an organism treats of the healthy working of the organism. It deals with the living, acting body, with what the body does and how it does it. Anatomy can be studied best upon the dead body. Physiology, however, must be studied chiefly upon the living body, since in death the action ceases. The present sketch is devoted particularly to the physiology of man, but we must bear in mind that physiology is a very broad science and has to do with all living things, animals or plants. Only a limited range of observation and experimentation is possible upon the living human being, hence the work of the physiologist consists chiefly of work upon animals other than the human species. Human physiology consists largely of careful, well-guarded inferences from the results of such experimental work.

Man the Result of Evolution.

The reasonableness of such a method of inference is apparent when one accepts as a fact what is no longer doubted by scientific men—that the human species is both anatomically and physiologically a form that has been derived from other and lower species of animals. Such a belief gives a unity and harmony, not otherwise possible, to the facts of biology. Man is physiologically interesting in himself; he is physiologically more interesting when regarded as the latest and most complex product of a long ancestry reaching back through mammals, reptiles, fishes, and a long line of simpler animals, to the most primitive forms. The study of these animals is a study of the steps by which man has arrived at his present stage.

Like other animal bodies, the human body is a complicated machine, adapted for doing a great variety of work. The term "vital energy" is often heard—a term which indicates that the living body is something fundamentally different from other machines that are made of iron, or

steel, or brass. During the present century, however, it has been proved that all kinds of energy in inorganic nature—such as mechanical work, heat, light, and electricity—are only different forms of a universal energy. Moreover, it has been shown that "vital energy" is not distinct from other kinds, and that the actions of the living body—walking, swimming, flying, speaking, the circulation of the blood, and probably the activities of gland cells, of brain cells, etc.—are performed according to the same mechanical, physical, and chemical laws that apply to inorganic matter. The task of the physiologist consists, then, largely in a study of the mechanics, physics, and chemistry of the living body. The goal toward which he is pressing is a full understanding of the nature of life itself. It is unnecessary to say that that goal is still far distant.

Protoplasm the Physical Basis of Life.

A great advance that has taken place during the past sixty years is the proof that life is always associated with a certain visible material substance. This substance is called *protoplasm.* It occurs in muscles, glands, skin, brain, bone, nerves, and all the organs. *It is in fact the living substance of all parts of all living bodies.* It is always associated with lifeless substance, such as the fluid parts of a body, the mineral parts of bones, the hard substance of teeth, the nails, the hair, and the microscopic lifeless material that permeates all parts of every body. In its simplest form protoplasm is a colourless, jelly-like, nearly transparent substance, somewhat resembling raw white of egg. It is a mixture of several chemical substances; it has a variable composition, but always contains carbon, hydrogen, nitrogen, oxygen, and sulphur. It differs in appearance and composition in different parts of the body, the protoplasm of muscle being identical neither with that of gland cells nor with that of nervous substance.

Organs, Tissues, and Cells.

Dissection shows that a body is composed of definite parts, or *organs*, each of which, as we shall see, has a definite function to perform. Thus the heart, the stomach, the eye, the liver, and the brain are organs. Each organ has its own peculiar structure, but each is made up of comparatively few structural substances. These substances are called *tissues*, and each tissue—such as connective tissue, muscle tissue, fat tissue—has its own work to do. Examination of the tissues with the microscope shows that each is composed partly of lifeless substance, usually in small quantity, and chiefly of minute living particles of protoplasm, the *cells* (Fig. 1). Cells vary greatly in shape and size and in the work that they do, but in any one tissue they are similar in structure and function. The work of a body is the sum of the work of its individual cells, and the fundamental problems in physiology lead back to protoplasm and the cells.

Every human body consists at first of a single cell within the body of

the mother. In growth the single cell divides into two cells, the two into four, the four into eight, and the process continues until in the adult millions of cells exist. Along with the increase in number there occurs a differentiation in form and a division of labour among the various cells, such that some come to perform the various muscular movements, others prepare digestive substances, others remove waste matter from the blood, others control the breathing, still others do the thinking, some are affected

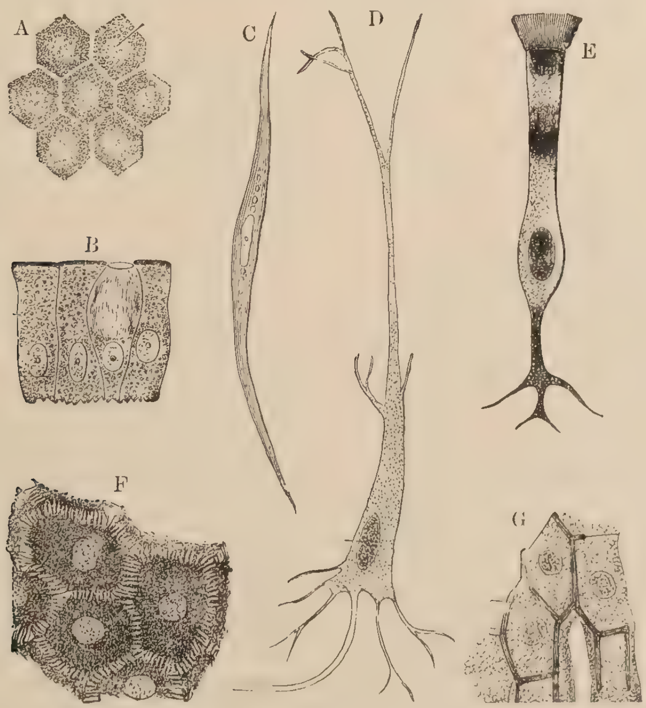

FIG. 1.—TYPICAL CELLS FROM THE HUMAN BODY.

Each cell consists of granular or striated protoplasm, and contains a denser protoplasmic mass, the nucleus. The nucleus is round or oval, and appears darker or lighter than the rest of the cell. A, seven pigment cells from retina (Schultze); B, four epithelium cells from intestine—one swollen with mucus represents a "goblet cell" (Frey); C, unstriped muscle cell (Arnold); D, nerve cell from brain (Gage); E, ciliated epithelium cell—the cilia constitute the brushlike upper end (Rosenthal); F, three "prickle-cells" from skin (Robinson); G, three gland cells from liver—the heavy dark lines represent bile ducts (Kölliker).

by waves of light, some by waves of sound, and thus we perceive that in this complicated human machine each part has its own work to do, and the division of labour is far-reaching.

Protoplasm is said to be irritable or excitable—that is, it is capable of being thrown into activity by proper stimuli. Every kind of cell, or tissue, or organ has its own natural method of stimulation and its own natural response or function. Every vital action is a response to some kind of stimulus.

The leading functions of the body, together with their chief agents, may be grouped as follows:

Functions.		Organs and other Agents.
Nutrition.	Alimentation.	Alimentary canal: consisting of mouth, œsophagus, stomach, small intestine and large intestine; liver; pancreas.
	Circulation ..	Blood system: consisting of heart, arteries, capillaries and veins; lymphatic system: consisting of lymphatic vessels and lymphatic glands; blood, lymph.
	Respiration ..	Trachea, lungs.
	Metabolism ..	All living cells.
	Excretion....	Lungs, kidneys and accessory organs, skin.
Motion..................		All muscles.
Co-ordination............		Brain, spinal cord, nerves, sympathetic nervous system.
Activity of special senses..		Eye, ear, organs of smell, of taste, of touch, of temperature, and of muscular sensations.
Support..................		Bones, cartilage, connective tissue.
Reproduction............		Female: ovaries and accessory organs. Male: testes and accessory organs.

CHAPTER I.

NUTRITION.

Like any other machine in action, the living human body constantly gives off energy to the outside world in the form of heat and mechanical work, and, moreover, its own material is being constantly used up. It requires food to replace these two losses of energy and substance. The story of nutrition is a long one. It tells how the body prepares for its use the food that is given to it (digestion); how the prepared food is taken into the distributing apparatus (absorption); how it is carried to the living cells (circulation); how it is used there for the production of new protoplasm, and how the protoplasm in action is destroyed, leaving waste matters (metabolism); and, finally, how the wastes, being harmful to the body, are removed from it (excretion). These subjects will now be considered in detail.

Section I.

ALIMENTATION.

Alimentation in General.

Alimentation consists of the two processes of digestion and absorption. Digestion comprises the chemical and physical changes which the food undergoes by way of preparation for entrance into the tissues, and for use by the living substance. Absorption is the process of the passage of digested food into the blood and lymph, whence it is carried to the tissues. Alimentation takes place in the alimentary canal (Fig. 2), which is a long tube

extending through the body, opening above at the mouth and below at the anus; its walls consist of muscle with glands, blood-vessels, and lymph-vessels. The successive parts of the canal are known as mouth, pharynx, œsophagus or gullet, stomach, small intestine and large intestine. To it are joined, by ducts, several large glands—namely, the three pairs of salivary glands, the pancreas, and the liver; all of these in their origin are outgrowths from the canal, but in the adult body they lie outside of its walls. The food enters at the mouth, and is propelled along the canal by the contraction of the muscular walls; the glands secrete—that is, manufacture and pour into the canal various fluids that differ in nature in various parts of the canal, and whose office it is to digest the food; the blood-vessels and the lymph-vessels, besides bringing blood and lymph to the walls of the canal, receive the digested food and bear it away to all parts of the body; the indigestible, the undigested, and the innutritious substances in the canal undergo chemical changes, and finally are expelled from the body as excrement.

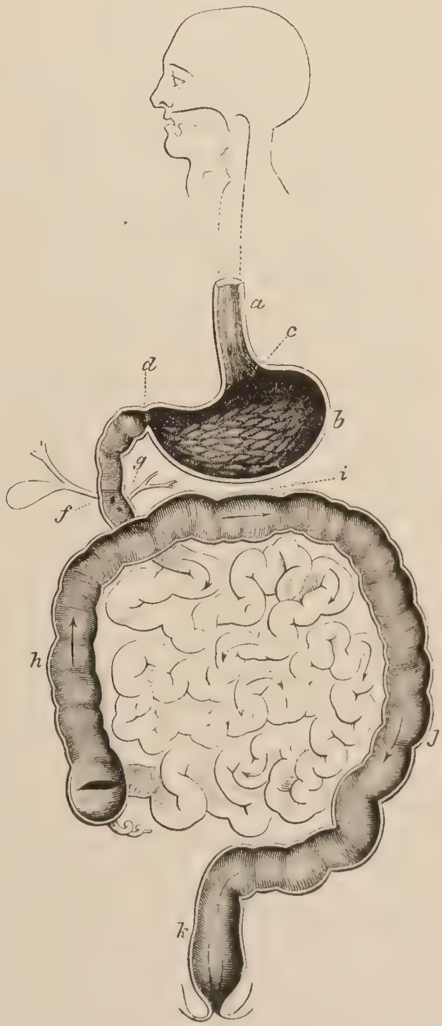

Fig. 2.—Human alimentary canal.

a, œsophagus; *b*, stomach: *c*, cardiac orifice; *d*, pylorus; *e*, small intestine; *f*, biliary duct and gall bladder; *g*, pancreatic duct; *h*, *i*, *j*, *k*, large intestine: *h*, ascending colon; *i*, transverse colon; *j*, descending colon; *k*, rectum. At junction of *e* and *h* is ileo-cæcal valve, below which is vermiform appendix. (Dalton.)

Food Stuffs.

The common foods, though apparently so different in character from each other, are found by chemical analysis to be mixtures of a small number of substances known as *food stuffs*. The most common food stuffs are *proteids* (the most important constituent of all meats, fish and eggs); *albuminoids* (such as gelatin; they are closely related to proteids, and hereafter will be included with them);

carbohydrates (such as starch and sugar, abundant in bread, pastry, and vegetables); *fats* (abundant in meats, butter, and milk); *water* and *salts* (such as table salt and numerous other salts). For a discussion of the characters and value of these various food stuffs the reader is referred to the article in this volume on *Hygiene*.

Digestion in General.

Water and the salts that are dissolved in the food are absorbed unchanged into the blood. Of the other food stuffs, proteids and carbohydrates are chemically changed by the digestive process, the former into closely related bodies called proteoses, peptones, and derivatives of the peptones, the carbohydrates mainly into a form of sugar called maltose, together with a small quantity of a starch called dextrin. By reason of the unsettled questions regarding the true nature of some of these digested substances, it will suffice hereafter to speak of all the products of proteid digestion simply as peptone, and of all the products of carbohydrate digestion as sugar. Contrary to what is found in most of the food stuffs, peptone and sugar are soluble, and hence when dissolved in the water of the food are fit for absorption. The digestion of the fats consists in part in changing them chemically into fatty acid, glycerin, and soap, and in part in simply breaking them up mechanically into minute droplets, this latter process being called emulsification; after these changes the fats are ready for absorption.

Digestive Fluids.

The digestive fluids are manufactured in the glands of the alimentary canal, and are poured out into it. They are five in number—viz., saliva, gastric juice, intestinal juice, pancreatic juice, and bile. Each consists chiefly of water together with a small quantity of dissolved solids, among which, except in the bile, is one or more of a peculiar class of bodies called *enzymes* or *unorganized ferments*, to which the digestive property of the fluids is due. The enzymes are peculiar chemical compounds, the exact constitution of which is unknown, but, when mixed with the food stuffs, they produce extensive chemical changes in the latter without being in themselves greatly altered.

Saliva is produced by the minute glands in the walls of the mouth and the three pairs of large salivary glands, the parotid, the submaxillary, and the sublingual (see *The Anatomy of the Human Body*). It is very watery, containing less than 0·6 per cent. of solids. Among the latter are *mucin*, which gives to the saliva its slightly slimy quality, and assists in the swallowing of the food; and *ptyalin*, an enzyme that changes starch into sugar. Saliva is produced in small quantity at all times, but more abundantly when food is in the mouth.

Gastric juice is produced by the innumerable small glands lying in the walls of the stomach. It is watery, colourless, sour, and contains three per cent. of solid matter. Its sourness is due to hydrochloric

(muriatic) acid. It contains two enzymes—viz., *pepsin*, which changes proteid to peptone, and *rennin*, which curdles milk. The glands of the stomach do not act continuously, but are stimulated to activity by the food that has been swallowed.

Intestinal juice is secreted by the glands in the walls of the small intestine. It is not abundant, is a yellowish alkaline fluid, and contains at least two kinds of enzymes, one like the ptyalin of saliva, capable of converting starch into sugar, and the other that changes maltose and other complex sugars into dextrose, a sugar of simpler composition.

Pancreatic juice is manufactured by the pancreas; it resembles saliva in appearance, but contains some thirteen per cent. of solids, among which are sodium carbonate and three powerful enzymes. Of these, *trypsin*, like pepsin, converts proteids into peptones, and, moreover, splits up some of the peptones into other bodies, the reason for which is not quite clear; *amylopsin*, like ptyalin, converts starch into sugar; *steapsin* splits up fat into fatty acid and glycerin. The fatty acid thus produced, with the sodium carbonate present, forms soaps that are capable of emulsifying fats. Hence pancreatic juice may digest all kinds of food stuffs.

Bile is produced by the liver. It is a yellowish or greenish-yellow, somewhat slimy, alkaline fluid, and contains two to three per cent. of solids that are of great variety, but apparently do not include any enzyme. Its secretion goes on continually, six hundred to eight hundred and fifty cubic centimetres (averaging a pint and three quarters) being produced in twenty-four hours. It is stored up in the gall bladder for a time, and passed out into the intestine during the course of digestion. The constituents of bile are largely waste products, thrown off by the living substance throughout the body, removed from the blood by the liver cells, and cast out into the intestine for expulsion. But in addition to its value as an excretion, bile is an important agent in alimentation, aiding greatly, in a manner not yet fully explained, the digestion and absorption of the fats.

Digestive Glands.

The glands that manufacture the digestive fluids consist of chemically active secreting cells that are richly supplied with blood and lymph. They have the power of removing from these fluids some components of the digestive fluids, like water and salts, and other substances from which they manufacture the remaining components. The resulting *secretion* passes on into the alimentary canal. The intestinal glands, the simplest of all, consist each of a little pocket opening into the intestine and with walls of secreting cells (Fig. 3). In the more complex pancreas, liver, and salivary glands the secreting pockets, or alveoli, are greatly branched, tortuous channels uniting into one tube, the duct, which conveys the secretion to the alimentary canal. The glands are among the most active of all the living parts of the body,

and are carefully controlled and regulated by the nervous system. The digestive ferments may readily be extracted from glands that have been removed from the bodies of dead animals, and may be used for the manufacture of artificial digestive fluids. With such fluids the processes of digestion of foods may be carried on under observation in vessels in the laboratory. This has been one of the most fruitful methods of studying the subject. Gland extracts form the basis of many substances used by the physician for the relief and cure of dyspepsia.

Fig. 3.—Gland from the human intestine.

The gland is dilated at its closed end; at the other end it opens into the intestine. Each of the secreting cells of which the wall consists contains a deeply shaded nucleus. The clear spaces represent cells laden with mucus. (Flemming.)

Digestion in the Mouth and Stomach.

Let us now trace in order the events of digestion. Food is put into the mouth, where its presence excites the salivary glands to manufacture and pour out upon it the saliva. The food is, or ought to be, chewed thoroughly, so as finally to divide it and thus to allow the digestive fluids to permeate it readily. The saliva mixes with it, and the chemical changes of digestion begin by the conversion of some of the carbohydrates present into sugar. By muscular action the food is swallowed—that is, is squeezed along through the pharynx and the gullet into the stomach, where it remains for a time varying from a few minutes to a few hours. Waves of contraction pass over the muscular walls; the food, being squeezed here and there, is kept in constant slow motion. The gastric glands are stimulated to activity, and the gastric juice oozing forth mixes with the mass of food and converts it into a half-fluid mass called chyme. The acid of the gastric juice puts a stop to further action of the swallowed saliva. Carbohydrates are hence here unchanged, but the proteids are in great part altered to peptones. At intervals the passageway into the small intestine—the pylorus—opens and allows the chyme to flow out into the duodenum. Thus gradually the stomach completes its work, and transfers its contents to the succeeding part of the alimentary canal.

Digestion in the Small Intestine.

In the small intestine the processes of muscular action, glandular secretion, and digestion are continued. The food is moved about and passed slowly along. The gastric juice ceases to act, intestinal juice and pancreatic juice are added to the mass, and the liver adds its contribution of bile. The carbohydrates that were unaffected by the saliva are changed into sugar.

The proteids that were unaltered by the gastric juice become peptones, and are even in part decomposed into simpler substances. The fats are for the first time affected, being in small part decomposed into fatty acid and glycerin, in greater part divided mechanically into fine droplets. This emulsification is assisted by the soaps that are formed by a union of the fatty acids and the alkalies present in the digestive fluids. Thus all classes of food stuffs are attacked in the small intestine; no other part of the whole canal forms so active a digestive laboratory as this part. Besides the changes already spoken of, due chiefly to the enzymes, the object of which is to make ready the nutriment for entrance into and use by the protoplasm, fermentative changes of the digested products take place of a destructive character, and due apparently to the agency of living microbes that are always present in the intestine. The significance of this apparent destruction of nutritive substance is not understood. The bacteria are not disease-producing germs; on the contrary, they may possibly be of considerable value to the body, but the rôle that they play needs investigation. Absorption of the digested food into the blood and lymph is most active in the walls of the small intestine, and by the time the semifluid mass has reached the ileo-cæcal valve it is robbed largely of its nutritious components.

Digestion in the Large Intestine.

In the large intestine no new physiological features are added. Feeble digestion, fairly active absorption of digestive products and of water, and marked fermentation by bacteria, are the main events; and the undigested and the indigestible substances are passed on into the rectum for expulsion from the body. The large intestine appears to be physiologically more important in herbivorous animals, like cows and sheep, where, in accordance with the enormous quantity of food, it is relatively large. It was doubtless larger and more important in the ancestors of the human race. But in man it appears to be undergoing degeneration, as is shown especially in the part known as the vermiform appendix. This appendage, probably valuable in the digestive work of the ancestors of man, seems to be devoid of marked function in man at the present time, and is especially prone to inflammatory processes set up by the presence within it of irritating substances brought there by the food. It would seem a blessing if evolution could hasten the disappearance of this apparently useless structure.

Vermiform Appendix.

Absorption.

A word now as to the absorption of the digested food stuffs, and the outline of the story of alimentation will be completed. Within the alimentary canal the food is no more a part of the body than if it were upon the outer surface. As has been insisted, digestion within the alimentary canal is merely a preparation of the food for entrance into the actual living substance. The cells that

line the canal are nourished by absorbing food directly from the mass that lies in contact with them. More distant cells require nutriment to be brought to them, and this is one important office of the blood and lymph with which the walls of the alimentary canal are so saturated. Thin-walled blood capillaries and lymph capillaries abound there, and during and after digestion the dissolved food stuffs make their way into them. Absorption takes place very slightly, if at all, in the stomach; it is at its greatest height in the small intestine, and it is active even throughout the large intestine. The method of absorption is not wholly clear. Probably physical processes play a leading part; but it is a question whether the living cells that line the intestine, and through which the food must pass on its way to the capillaries, may not in some manner engage actively in the process. Sugar and fats pass through them unchanged, peptone is mysteriously altered chemically in its passage. This altered peptone, the sugar, and the greater part of the salts and the water go directly into the blood. Fat goes into the lymph and, by way of the lymphatic vessels and the thoracic duct, finally into the blood system. Thus all nutriment that is not used by the living substance in the wall of the alimentary canal finds its way sooner or later to the blood, the great carrier and distributer of matter and energy. Our next section deals with this circulating mechanism.

Section II.

CIRCULATION.

In an organism that consists of one cell or a few cells, food, when once digested, permeates all parts readily. In larger organisms this is impossible, and hence special mechanisms must exist for the transfer of nutriment from the organs of digestion to the more distant parts. In the growth of all except the simplest animals such a mechanism, some sort of a distributing system, is developed. It is simple and crude in its beginnings, and in the lower organisms remains always simple and crude. It becomes more complex and perfected as the animal's size increases and his structure becomes more complex, until in the completed circulatory system of the highest animals and man we have an apparatus that is wonderfully adapted to perform its needed work, and responsive in a high degree to the demands of the other physiological systems. The transfer of nutriment is not the only important function of the organs of circulation. Of equal value are the transfer of oxygen without which the living substance can not act, and the removal of waste products from the tissues to the organs of excretion. Furthermore, it must be borne in mind that the

Circulation in General.

food contains not only material for the manufacture of new protoplasm, but also in a latent form all the energy of which the body makes use; hence the circulation is the medium for the transference of energy from one part of the body to another. Finally, as we shall discuss later, the same system acts to keep the temperature of the various portions of the body uniform. A review of the circulation comprises a study of the two fluids which serve as carriers of the oxygen, the food, the energy, and the wastes—viz., the *blood* and the *lymph*, and a study of the organic mechanisms by which they are made to move.

Blood and its Constituents.

Blood may be regarded as a tissue consisting of a lifeless, slightly yellowish liquid, the *plasma*, and living cells, the *corpuscles*. The plasma contains in solution the food and the waste matters, hence its composition is complex. Besides water, it contains eight to nine per cent. of solid substances, comprising among other bodies proteids, sugar, fats, and salts. Some of these constituents originate in the digested food stuffs. It contains also a gas, carbonic acid.

The corpuscles are of three kinds, the red, the white or colourless, and the blood-plates, which are also colourless (Fig. 4). The red corpuscles are most numerous, it being estimated that in one cubic millimetre of blood ($\frac{1}{15625}$ of a cubic inch) there exist five millions in man and about a half million less in woman. The number in the whole body is inconceivably great. They are biconcave round disks about $\frac{1}{3200}$ of an inch in diameter, and consist of a bit of protoplasm coloured by a reddish pigment called *hæmoglobin*. Hæmoglobin gives to the blood its colour, and is one of its most important constituents by reason of having a special attraction for oxygen. When the blood in its course passes through the lungs, its hæmoglobin absorbs oxygen from the air that has been breathed in, and holds it until the gas

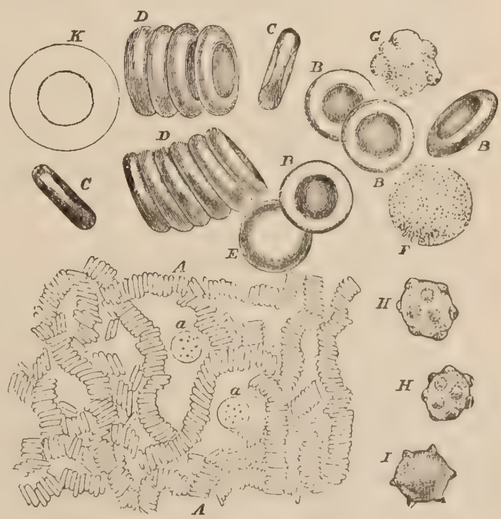

FIG. 4.—RED AND WHITE CORPUSCLES OF THE BLOOD, MAGNIFIED.

A, moderately magnified: the red corpuscles are seen lying in rouleaux; at *a* and *a* are seen two white corpuscles; *B*, red corpuscles much more highly magnified, seen in face; *C*, ditto, seen in profile; *D*, ditto, in rouleaux, rather more highly magnified; *E*, a red corpuscle swollen into a sphere by imbibition of water; *F*, a white corpuscle magnified same as *B*; *G*, ditto, throwing out some blunt processes; *K*, ditto, treated with acetic acid, and showing nucleus, magnified same as *D*; *H*, red corpuscles puckered or crenate all over; *I*, ditto at the edge only. (Huxley.)

is required by the tissues. The task of the red corpuscles is hence that of carriers of oxygen. In cases of murder or other crimes, where a stain is suspected to be caused by blood, an examination with the microscope, by revealing the red corpuscles, will decide the question. Even if the corpuscles have been destroyed, the presence of hæmoglobin can easily be detected by proper chemical methods. Human red blood-corpuscles may be distinguished readily from those of fishes, frogs, reptiles, or birds, but not conclusively from those of higher animals except the camel. Human hæmoglobin is not distinguishable from that of other animals.

The white corpuscles are colourless cells of somewhat irregular shape, roughly spherical, about $\frac{1}{2400}$ of an inch in diameter. They are much fewer in number than the red corpuscles. They have the peculiar power of creeping about through the walls of the blood capillaries, and in among the cells of the tissues throughout the body. Their specific work is not fully known. It has been thought that they may be of special benefit to the body, when attacked by germ diseases, by absorbing the bacterial germs into their substance and destroying them.

The blood-plates were discovered only recently. They are minute, colourless, spherical, or elliptical bodies, that go to pieces very easily. This happens especially when blood is shed, in which case they seem to aid in the clotting of the blood. Their office within the body is unknown.

The quantity of blood in a healthy man of one hundred and fifty pounds is about five and a half quarts.

When blood is shed it has the peculiar property of clotting or thickening into a jelly-like mass. The special value of this property lies in its use in stopping the loss of blood from wounds; if it were not for this, the slightest injury to the skin might result in bleeding to death. Clotting consists in the formation from *fibrinogen*, one of the proteids existing in the plasma, of an insoluble substance called *fibrin*. Fibrin exists in the clot in the form of fine whitish threads that extend in all directions and form a spongy network. This holds in its meshes the corpuscles, and the whole forms an effectual plug for the wound. By the spontaneous shrinking of the fibrin threads a yellowish fluid, that is really plasma minus the fibrin and is called *serum*, is squeezed out.

Lymph.

Lymph is a colourless fluid, occurring partly in the lymphatic vessels and partly in the spaces between the cells of the tissues. It thus comes more closely into contact with the living protoplasm than the blood, the latter never leaving its vessels. It is much like blood in composition, but lacks the red corpuscles and the blood-plates. After a meal of fat the lymph in the lymphatics of the intestine is loaded with fat droplets, and is pure white in colour like milk,

the whiteness of which is due to the contained droplets of butter. Such lymph is called *chyle*, and the lymphatics in that region are known as *lacteals*.

Circulation of the Blood.

The blood is moved through the blood-vessels by the contractions of the heart. The motion was thought formerly to be a sluggish oozing from the heart to the tissues. But in 1628 it was shown by the Englishman, William Harvey, physician to Charles I., that every particle of blood makes a complete circuit of the blood-vessels, and returns ultimately to its place of starting; that the blood moves, so to speak, in a circle, and since Harvey's time the movement has been spoken of as the circulation of the blood. The circulatory organs of the blood system consist of the heart, the arteries, the capillaries, and the veins. The heart pumps the blood into the main arteries; along these the liquid courses toward the tissues, passing into smaller and smaller arteries, and finally into the minute capillaries; in the capillaries it permeates the tissues and courses among the living cells; from the capillaries it passes into the small veins; these unite into larger and larger vessels, and finally, by a few large venous trunks, the blood returns to the heart again. For the structure and arrangement of the circulatory organs, and for the general plan of the circulation, the reader is referred to the article on *The Anatomy of the Human Body*, Sections IV and V, and to the accompanying figure (Fig. 5). In order to make the complete circuit of the circulatory organs, any particle of blood must traverse two sets of arteries, capillaries, and veins, and all four chambers of the heart. The path from the left ventricle through the blood-vessels of

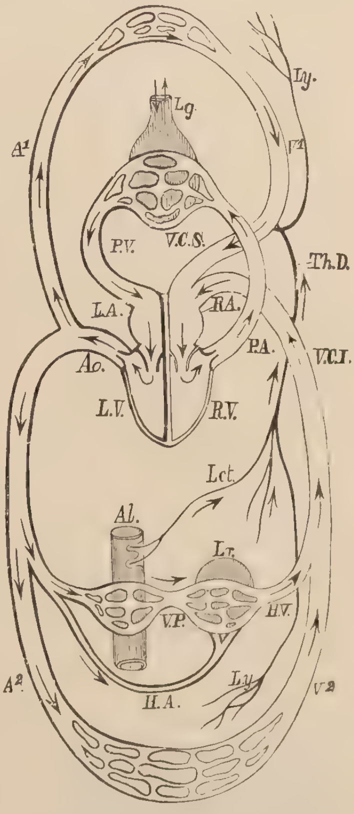

Fig. 5.—Diagram of the heart and vessels, with the course of the circulation, viewed from behind, so that the proper left of the observer corresponds with the left side of the heart in the diagram.

L.A., left auricle; *L.V.*, left ventricle; *Ao.*, aorta; A^1, arteries to the upper part of the body; A^2, arteries to the lower part of the body; *H.A.*, hepatic artery, which supplies the liver with part of its blood; V^1, veins of the upper part of the body; V^2, veins of the lower part of the body; *V.P.*, vena portæ; *H.V.*, hepatic vein; *V.C.I.*, inferior vena cava; *V.C.S.*, superior vena cava; *R.A.*, right auricle; *R.V.*, right ventricle; *P.A.*, pulmonary artery; *Lg.*, lung; *P.V.*, pulmonary vein; *Lct.*, lacteals; *Ly.*, lymphatics; *Th. D.*, thoracic duct; *Al.*, alimentary canal; *Lr.*, liver. The arrows indicate the course of the blood, lymph, and chyle. The vessels which contain arterial blood have dark contours, while those which carry venous blood have light contours. (Huxley.)

the body, except the lungs and to the right auricle, is called the "greater" or "systemic" circulation; the path from the right ventricle through the vessels of the lungs to the left auricle is called the "lesser" or "pulmonary" circulation. The significance of this double circulation lies in the facts that in the capillaries of the tissues of the body the blood delivers up food and oxygen to the cells and receives waste products from them; and that in those of the lungs the gaseous waste, carbonic acid, is thrown off into the air to be expelled in the breath, while the blood is in return charged highly with oxygen. The left side of the heart hence carries purified blood charged with oxygen, the right side impure blood charged with carbonic acid and other waste matters. These latter wastes are removed from the blood capillaries and from the body by the kidneys and the skin. As has been already said, the food is received into the circulation partly in the capillaries of the intestinal wall and partly directly into the veins from the lymphatic ducts.

Structure and Function of Vessels.

Thus all exchange between blood and living protoplasm takes place through the capillary walls. In harmony with this function these walls consist of a thin membrane made up of flat cells joining one another edge to edge, and allowing a ready diffusion of the liquid blood plasma (Fig. 6). As the capillaries pass on the one hand into the arteries, and on the other into the veins, the walls become thickened by the addition of a layer of muscle outside of the lining membrane and one of connective tissue outside of the muscle. Both these layers are thicker in the arteries than in the veins, and in the former the connective tissue is highly elastic. Thus the arteries are thick-walled, active, elastic structures, capable of altering their calibre greatly, and thus regulating the amount of blood going to the capillaries. If a particular capillary area requires a large quantity of blood, the muscles of the adjoining arteries relax and the arteries dilate; if less blood is desired, the muscles contract and constrict the supplying arteries. The veins are thinner walled and passive, and are in brief drainage-tubes for the capillaries and the tissues. The arteries are thus physiologically more interesting than the veins. If an artery be cut, the thickness and stiffness of its walls cause it to stand wide open, and the blood gushes freely out; if a vein be severed, its walls collapse, and the blood hindered in its flow may clot more readily and less loss may result. Hence wounding an artery is usually a much more serious and dangerous affair than wounding a vein. In this

FIG. 6.—CAPILLARY CIRCULATION IN THE WEB OF THE FROG'S FOOT.

connection it is interesting to recall the fact that as a rule the arteries lie much farther from the surface of the body than the veins—a most valuable adaptation of Nature. Exceptions to the rule are the radial artery which comes near to the surface at the wrist, the artery at the temple, and a few others. But the veins have one mechanism peculiar to themselves—that is, the curious and very numerous little pouch-like valves that project into the tubes and prevent any back-flow of blood toward the capillaries when any influence, such as pressure on the skin, tends to hinder the venous flow (Fig. 7). Even if the veins are thin-walled and inactive, their valves do not allow their circulation to be seriously interfered with by extraneous pressure.

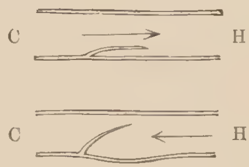

Fig. 7.—Diagrammatic section of veins with valves.
In the upper figure the blood is supposed to be flowing in the normal direction from C (capillary) to H (heart); in the lower figure pressure upon the surface of the vein has temporarily forced the blood backward and closed the valve. (Huxley.)

Physiological Anatomy of the Heart.

The heart in its embryonic origin is a simple tubular blood-vessel, and in some of the lower and simpler organisms, such as the worms and the tunicates, it retains its tubular character throughout life. But in the growth of all higher animals, including man, its simple form is early modified by its being curved upon itself, by partitions forming within its cavity, by valves appearing at certain places, and by its walls becoming greatly thickened by muscular tissue. It thus becomes a complicated muscular pump, a part of the circulatory system specially modified by Nature for the purpose of propelling the blood around its circuit. For the details of the anatomy of the heart the reader is referred to the article on *The Anatomy of the Human Body*, Fig. 27. It will be remembered that the organ is four-chambered, comprising two thin-walled upper chambers, the auricles, and two thick-walled lower ones, the ventricles. A partition extends the whole length of the heart, separating the auricle and ventricle of the right side from those of the left side. Each auricle receives blood from veins, and opens below into the corresponding ventricle. The pulmonary veins, bringing blood from the lungs, join the left auricle; the two great veins that bring blood from the rest of the body, the superior and the inferior venæ cavæ, enter the right auricle. Each ventricle opens into an artery—the right one into the pulmonary artery which conveys blood to the lungs, the left one into the aorta, which is the largest artery of all, and supplies with blood all parts of the body except the lungs. The course of the blood stream has been mentioned already, and may be seen readily from the accompanying diagram (Fig. 5). The direction of the flow is determined by the valves. Of these there are two kinds: the auriculo-ventricular valves at the opening of each auricle into

its ventricle, and the semilunar valves at the origin of both the aorta and the pulmonary artery. The former allow the blood to pass from the auricles to the ventricles, but not to return; the latter allow it to flow from the ventricles into the arteries, but not to return.

Beat of the Heart.

The movement of the blood is caused by contractions of the muscle in the walls of the heart, the muscle being so arranged that each contraction diminishes the size of the heart chambers, and the blood is thereby squeezed upon and forced out. The contractions are commonly called "beats," and are performed rhythmically. In the newborn child the heart beats at the rate of one hundred and thirty to one hundred and forty times in the minute. During childhood and youth the rate gradually diminishes, and throughout the greater part of adult life remains at about seventy-two. The events of each beat in brief and in order are as follows: The gradual flowing of blood from the veins into the auricles and from these into the ventricles; the sudden short contraction of both auricles for the purpose of overfilling the ventricles and causing the auriculo-ventricular valves to rise upward and shut off communication between auricles and ventricles; sudden contraction of both ventricles by which the contained blood is put under tension, the semilunar valves are pressed open, and the blood is shot out into the aorta and the pulmonary artery with sufficient force to drive it through the arteries, the capillaries, and the veins back again to the opposite auricle. Immediately after contraction the semilunar valves close, each heart chamber relaxes and fills with blood from the veins, its muscles rest, and, in a fraction of a second, have recovered energy for a second beat. This follows, and a third, and a fourth, and so the cycle is repeated with alternations of activity and of rest, of systole and diastole, throughout the life of the individual, the order of events never changing unless some form of "heart disease" interferes with the working of this most beautiful of all animal mechanisms.

Heart Sounds.

It is apparent that the course of the blood along the arteries is intermittent, wave after wave following one another at intervals of less than a second. Each wave or *pulse* is, of course, the direct result of the ventricular beat, and hence the physician regards the pulse as one of the best indications available to him of the condition of the heart. The practised ear may infer much also from the *heart sounds*, which may be heard readily by laying the ear on the chest wall over the heart. These are two—a longer, faint, low-pitched tone, due to the contraction of the ventricles, and immediately followed by a short, higher-pitched, abrupt one, caused by the closing of the semilunar valves. If the parts are altered by disease the sounds are altered.

The smaller arteries and the capillaries are excessively fine tubes, the diameter of some of the latter being even as small as $\frac{1}{3200}$ of an inch, the

diameter of a red corpuscle. The result is that the resistance to the flow in them is enormous, and the blood tends constantly to accumulate in the arteries. The walls of the arteries are thereby put under great tension, the pressure of the blood within them is great, and their elasticity is brought into play. The result of this combined capillary resistance and arterial elasticity is that by the time the blood has reached the smallest vessels the pulse has disappeared, and the flow is continuous in both the capillaries and the veins. Many more details might be given of the events of the blood movement were there space, for even from the very earliest times, and especially since, in 1628, Harvey gave the right interpretation of the leading facts, and since Malpighi, in 1661, first saw with his microscope the exquisite and wonderful picture of the blood corpuscles picking their way through the tortuous capillary channels in the wall of the frog's lung, the circulation has been a favourite study with all schools of physiologists. Many of the once mysterious facts have been shown to be explicable by the common laws of mechanics. Although the heart is a living pump and the vessels living tubes, the circulatory system presents many of the same problems as are presented by any system of closed elastic pipes through which liquid is pumped. Other problems, however, defy the attacks of the mechanical, physical, or chemical physiologists, and prove that the experimental laboratories have still much to do.

Of these latter problems, which for lack of a better word may be called "vital," two may here be mentioned—viz., the causation of the heart beat, and the regulation and co-ordination of the various parts of the circulatory apparatus. The beat itself is an excellent example of what physiologists are wont to call spontaneous actions—*i. e.*, actions which originate within the tissue itself, and do not require a stimulus from without to set the tissue going. By this is not meant a causeless action; every action has one or more causes, but the causes of spontaneous actions are to be sought within the acting part itself. The beat of the heart is a spontaneous action. It has been abundantly proved in lower animals and even in the higher quadrupeds that the heart when removed from the body will continue to beat even for hours if it be supplied with proper nourishment and warmth, and this fact no doubt would apply to the human heart, were it possible to test it. The impulse to the beat is then to be sought in the heart itself, but in what tissue? The heart contains much nervous tissue, consisting of nerve cells, which send off filaments, the nerve fibres, to the cardiac muscle cells. In general it may be said that nerve tissue is more inclined to spontaneity than muscle tissue. Within the heart, then, does the impulse to beat originate in the muscle cells that do the contracting, or does it originate in the nerve cells and pass from them along the nerve fibres to the muscle cells? The question is a fundamental one for physi-

Cause of Heart Beat.

ologists, and its answer would be a valuable contribution to the interesting subject of the evolution of muscular and nervous function. In the lower and simpler animals spontaneity is a characteristic of almost all kinds of cells and tissues; as the evolution of the higher animals has gone on, gradually the tissues have become less spontaneous in their actions and more dependent upon impulses coming to them from the nervous system, until, in the higher animals, the work of the body is largely performed as the result of nervous action. In accordance with this the nervous system retains its primitive spontaneity in a high degree. In the hearts of invertebrates, as the snail, and perhaps some low vertebrates, as the frog and the turtle, the impulse to beat appears to originate in the cardiac muscle cells; in the higher vertebrates it is yet unsettled whether it is nervous or muscular in origin. Why the heart tissue acts rhythmically is another inviting subject, not yet understood, into which we have here not time to go.

Nervous Control of the Heart.

Although, as we have seen, the heart does not need any impulse from outside to enable it to continue its contractions and do its work, yet its contractions are always regulated and controlled by nervous impulses coming from the brain. From the part of the brain lying at its base and called the medulla oblongata, situated just within the skull at the back of the neck, nervous impulses go out to the heart along certain nerves. Along the two vagus nerves (see *The Anatomy of the Human Body*) may go impulses which cause the heart to beat more slowly or more weakly than before. These come from the so-called *cardio-inhibitory centre* in the medulla, and if sufficiently intense they may cause the heart actually to stop beating. Along the sympathetic nerves may go impulses that cause the heart to beat more rapidly or more strongly than before; these come also from an *augmentor* or *accelerator centre* situated probably in the medulla. These two centres are thus antagonistic in their action on the heart. They are in nervous connection with other parts of the central nervous system and thence with all parts of the body, and through them the heart is delicately controlled constantly as to rate and force of beat, so that its work is adapted to the needs of the body at every moment. As examples of extreme activity of these nerve centres may be mentioned, first, the slowing or actual stopping of the heart by a sudden heavy blow in the pit of the stomach, or by a sudden shock caused by a piece of bad news. In both cases the cardio-inhibitory centre is stimulated to activity; in the former through nerves going up from the stomach to the medulla, in the latter through nerve fibres within the brain itself, extending down from the consciously acting brain centres above that have taken cognizance of the bad news. In both cases the result, as stated, is slowing or stopping of the heart; the fainting that usually accompanies is a secondary result, due

to the fact that the weakened heart fails to pump the necessary blood to the consciously acting brain, and unconsciousness results. Second, the very rapid fluttering of the heart accompanying mental excitement is no doubt due to excessive stimulation of the accelerator centre, and thus of the heart, by impulses coming likewise down from the higher brain cells. A little consideration will show that slowing of the heart may result theoretically from activity of inhibitory nerves or from the cessation of activity of accelerator nerves; and the like applies *vice versa* to acceleration. Physiology has not yet unravelled all the mysteries of the interactions of these two antagonistic nerve influences. It may be mentioned here incidentally that the rapid pulse present in fever is probably due to the hot blood stimulating directly the heart muscle to excessive activity.

Nervous Control of the Arteries.

The blood supply to the various parts of the body must needs vary constantly, according as any part requires more or less blood at one time than at another. A tissue in action needs more blood than the same tissue at rest, because it needs more food and more oxygen, and because the injurious waste products of its activity must be removed. When the brain thinks, it needs more blood than when it sleeps; when the digestive glands are secreting, they must have blood in abundance; when a man works with his muscles, they demand an extra allowance of blood. Obviously, mere alteration of the heart beat affects the general blood supply, but affects all parts equally. Nature has, however, evolved an efficient method of varying the supply according to the needs of the individual parts. The method consists in varying the calibre of the artery that brings blood to each part. Constriction or narrowing of an artery causes the quantity of blood to be diminished; dilatation or widening causes it to be increased. The calibre of the arteries, like the action of the heart, is regulated through special nerves by a particular part of the brain. Such nerves are called *vaso-motor*, from the fact that they supply the muscles or motor part of the arterial walls. The vaso-motor nerves are of two kinds, quite analogous in their functions to the two kinds of cardiac nerves: the *vaso-constrictors* have the power of causing the muscular coat of the arterial walls to contract, and thus a constriction of the artery results (analogous to augmentation of the heart beat); the *vaso-dilators* cause relaxation of the arterial muscle and hence a dilation of the vessel (analogous to cardiac inhibition). These nerves go to the arteries from a *vaso-motor centre* in the medulla oblongata. This part of the brain, like the cardio-inhibitory centre near which it lies, is affected by influences coming from all parts of the body, and its actions are determined by the nature of these influences. It is capable of controlling the calibre of each artery, and thus of constricting or dilating small or large vascular areas. Like the case of cardiac augmentation or inhibition, arterial constriction and dilation may

result theoretically not only from direct constricting and dilating impulses, but each may also follow from the cessation of impulses leading to the opposite activity. Hence the mutual interactions of these two influences become excessively complicated and present a problem not yet wholly solved. As examples of vasò-motor actions may be mentioned the two cases of blushing and becoming pale, due in the one case to arterial dilation, and in the other to arterial constriction, of the small arteries in the skin of the face. The exciting cause in each case is an unusual thought or emotion originating in the brain and causing nervous impulses to pass down to the vaso-motor centre in the medulla, in the one case decreasing its activity, in the other increasing it. Just why one emotion causes blushing and another paleness is not clear. As might have been expected, of all the blood-vessels the arteries alone are known to be markedly controlled by nerves. The vaso-motor nervous apparatus and the cardiac nervous apparatus are connected within the medulla and work in harmony with each other. Together they form a mechanism of remarkable adaptation and refinement.

The Lymphatic System.

As will be seen from the article on *Anatomy*, the lymphatic system is comparable in a general way with the capillary and the venous systems—*i. e.*, it consists of capillaries uniting to form larger vessels, and these in turn unite into two large trunks. The capillaries take their origin in irregular spaces among the tissues. (See *The Anatomy of the Human Body*, Fig. 36.) The lymphatics receive openings from such large cavities as those of the abdomen, of the chest, and of the pericardium. At intervals they open into the irregular cavities within the lymphatic glands. And finally the two trunks, the thoracic duct and the smaller right lymphatic duct, open into the great veins at the root of the neck. The walls of the lymphatics are not unlike those of the capillaries and veins in structure, but they are excessively thin. Valves, like the venous valves, are very abundant in the vessels. The lymph not only fills the lymphatic organs, but exists also in all cell spaces and interstices of the tissues, and thus bathes the living cells much more intimately than does the blood. The lymph may be regarded as a carrier between the blood and the living cells, all food and all waste matters probably having to pass through it in their passage between the protoplasm and the blood-circulating system. The plasma of the lymph is blood plasma that has escaped through the thin walls of the blood capillaries into the spaces in the surrounding tissues; the corpuscles of lymph are in part escaped white blood-corpuscles and in part new cells that are formed by division of cells within the lymphatic glands. The lymph thus originating constantly in the tissues passes into the lymphatic capillaries, flows constantly along the vessels, and empties itself into the veins. In all vertebrates below the mammals a varying number of lymph hearts

exist—simple muscular sacs attached to various lymphatic vessels, and capable, like the blood heart, of rhythmic contractions. No such organs are known to exist in man and other mammals. The movement of the lymph is due to several agencies, such as pressure exerted upon the vessels by the muscular movements of the body, the existence of a lower pressure in the veins than in the lymph-vessels themselves, and possibly rhythmic contraction of the walls of the vessels. The numerous valves prevent any possibility of a flow in the wrong direction. Thus both structurally and functionally the lymphatic system is a much less highly specialized apparatus than the blood system. The latter, with its efficient means of propulsion and its elaborate nervous mechanism for regulating speed and distribution, is, like the railway system, an efficient and rapid carrier. But, just as between the factory and the railway, or between the latter and the consumer, the drayman's cart is indispensable, so in the body, between the place of digestion and the blood, or between the blood and the living cells, the lymph finds its tasks. The lymphatic system and the blood system together form a most efficient distributing and collecting mechanism.

We have thus traced the food from outside the body to the living cells. Without oxygen the cells can not utilize it. We have now to consider the source of the oxygen.

Section III.

RESPIRATION.

The lungs and other respiratory organs have a twofold function—that of bringing to the blood the oxygen that is as essential to life as is the food, and that of removing from the blood and from the body water and certain waste and poisonous products, mainly carbonic acid. The great importance of the whole process is indicated by the facts that the respiratory organs occupy so large a space in the body; that the right ventricle of the heart has as its sole function that of supplying blood to them; and that during the lifetime of the individual all the blood in the body must pass through them once in every twenty or twenty-five seconds—the time occupied by the blood in making the complete circuit of the body. To insure rapid and efficient exchange of the two gases, oxygen and carbonic acid, the blood and the air must be brought into as close proximity to each other as possible; hence we find the lung to consist mainly of innumerable

Respiration in General.

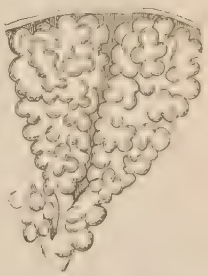

Fig. 8.—Termination of two bronchial tubes in enlargement beset with air sacs. (Huxley.)

small *air sacs* (Fig. 8) with excessively thin walls containing a little elastic connective tissue lined by a layer of flat, thin epithelium cells, and loaded with a rich network of fine blood capillaries. The air sacs are continuous with the bronchial tubes, and communicate through the trachea with the outside air (Fig. 9). The blood is separated from the air by the thin epithelial membrane consisting of capillary wall and wall of air sac

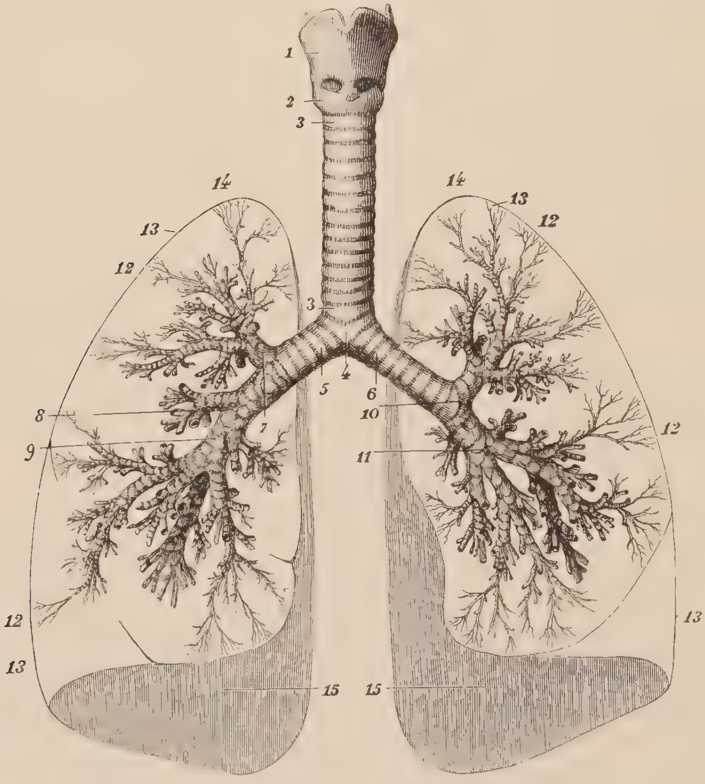

FIG. 9.—TRACHEA AND LUNGS, DISSECTED TO SHOW BRONCHIAL TUBES.
1, 2, larynx; 3, 4, trachea; 5, 6, bronchi; 7, 8, 9, 10, 11, bronchial tubes, a few only being shown as far as their terminations; 12, 13, 14, 15, surface of lungs. (Sappey.)

(Fig. 10). Thus the conditions needed for ready diffusion are present. The total amount of air surface exposed in the lungs appears to be more than two hundred square yards, and the amount of capillary surface more than a hundred and fifty square yards. The blood is renewed constantly by the circulation; the air is exchanged constantly by the respiratory movements; and the result of the interchange between the two media through the intervening membranous wall is that, while impure blood and pure air have entered the lungs by their respective channels, pure blood and impure air go out from them.

Respiratory Movements.

The respiratory movements consist of those of *inspiration* and *expiration.* In both of these acts the lungs are passive organs. The activity resides in the muscles of the chest walls. It will be remembered that the lungs are inclosed within an air-tight cavity, the thorax or chest, which is bordered at the top and sides by the ribs and the intercostal muscles, and below by the dome-like muscular partition, the diaphragm. Contraction of the external intercostal muscles raises the ribs, pushes the sternum or breast bone outward, and enlarges the whole chest cavity. Enlargement of the chest may be brought about also by contracting and thereby lowering the diaphragm. The inspiratory act consists in enlarging the chest by simultaneous contractions of both these muscles with the assistance of other muscles of the thoracic walls. The walls of the lungs follow passively the movements of the walls of the air-tight and air-empty chest, and the capacity of the lungs is correspondingly increased ; to balance this the air rushes in passively through the nostrils or mouth, pharynx, trachea, and bronchial tubes. Thus we do not breathe air in, as our sensations might mislead us to believe, through any action exerted upon the air by our nostrils or lungs. When we wish air we contract our diaphragm and the muscles of our ribs, and air must come in. Both sexes use both muscles, but in women respiration by movement of the ribs, or "costal" respiration, predominates ; in men the "diaphragmatic" or "abdominal" method is more prominent. It has been greatly discussed and is still undecided whether this is a fundamental sexual difference associated with the function of childbearing in woman, or whether it is due to the tightness of woman's dress about the abdominal region and the prevention of the free action of the diaphragm. The expiratory act is the reverse of that of inspiration : the muscles cease their contraction, the ribs and the diaphragm return to their former positions, the tension on the lungs is removed ; by their elasticity the lungs return to their former size, and the excess of air is squeezed out. Only when the breathing becomes laboured, as in active exercise, or when from any unusual cause there is danger of suffocation, does expiration become a muscular act, carried on by various muscles attached to the walls of the chest and the abdomen. Respiration is a rhythmic, ordinarily unconscious action, repeated on an average seventeen to eighteen times in the minute in the adult, but more rapidly in children.

Sexual Differences in Respiration.

FIG. 10.—DIAGRAMMATIC VIEW OF AN AIR SAC.

a, lies within sac and points to epithelium lining wall ; *b*, partition between two adjacent sacs, in which run capillaries : *c*, elastic connective tissue. (Huxley.)

At each respiration about thirty cubic inches of air ("tidal air") passes into and out of the air passages and mixes with the "stationary air"

(about one hundred and eighty cubic inches) that the lungs contain at all times. The actual exchange of gases between the tidal and the stationary air takes place by diffusion. The result of the exchange is that the expired air is saturated with moisture, is warmer than the inspired air, and contains about five per cent. less oxygen, about four per cent. more carbonic acid, and a minute quantity of obscure deleterious substances of unknown nature, to which the odour of the breath is due.

Respiratory Changes in Air.

The respiratory muscles are not, like the heart, automatic; they need to be stimulated for each contraction; and a particular part of the brain has been specialized to originate and send out to them the necessary impulses. This is the so-called *respiratory centre* or "vital spot," and it lies in the medulla oblongata at the base of the brain. Its presence there makes this portion of the brain seem so important, for any serious injury to the centre stops respiration and thus puts an end to life. Hence the fatality in breaking the neck. The nerve cells composing the centre are put into activity, apparently, by the impure venous blood circulating about them; they inaugurate an inspiratory impulse and discharge it along the intercostal and the phrenic nerves to the respiratory muscles, causing the latter to act. Exactly how the regular alternation of inspiration and expiration comes about is not wholly explained, but the centre seems to be regulated in its activity by nerve impulses coming from the lungs. It is, in fact, one of the most sensitive parts of the nervous system, all modifications of breathing that take place in laughing, crying, coughing, sneezing, hiccoughing, sighing, "catching one's breath," muscular exercise, talking, singing, stepping into a cold bath, etc., being due to influences altering the regular working of the respiratory centre. The peculiar facial expressions and characteristic vocal sounds that accompany laughing and crying are to be distinguished from the modified breathing. It is not easy to conceive how and why these peculiarities of facial expression, sounds and breathing, which are evidences of pleasure or of grief, and the beginnings of which seem to be found in animals lower than man, have been developed.

Nervous Control of Respiration.

The changes that the blood undergoes in its passage through the lungs are in harmony with and are no less striking than those of the air. The blood loses to the air contained in the air sacs of the lungs six to eight per cent. of carbonic acid, and gains from it eight to twelve per cent. of oxygen; it comes to the lungs purplish in colour; it leaves them bright scarlet. The gaseous exchange between air and blood takes place chiefly by the physical process of osmosis through the thin cellular membrane separating them; but the cells of this membrane may possibly act like gland cells to "secrete" the two gases.

Respiratory Changes in the Blood.

The change of colour of the blood is interesting. It will be remembered that the red colour is due to the colour of the hæmoglobin that exists in the red corpuscles, and also that the red corpuscles are the carriers of oxygen. The hæmoglobin exists in the body in two forms—in venous or impure blood, largely as *reduced hæmoglobin*, and in arterial or pure blood, as *oxyhæmoglobin*. Reduced hæmoglobin contains little oxygen and is purplish in colour; oxyhæmoglobin contains much oxygen and is scarlet in colour. The hæmoglobin that is brought to the lungs is in the reduced form; it greedily seizes upon the oxygen that is absorbed through the capillary walls; it becomes oxidized; and the colour of the hæmoglobin, the red corpuscles, and the blood changes accordingly to the bright-red tint.

Colour of the Blood.

Besides the pulmonary respiration, slight exchange of oxygen and carbonic acid takes place directly through the skin. This method of breathing is of great importance to some of the lower animals, such as frogs and worms, but in man it is very subordinate.

Respiration by the Skin.

The specific respiratory organs work for the body as a whole. In the broad sense, however, all living cells are respiratory, since they take in oxygen and give out carbonic acid. Such a process is often spoken of as *internal* or *tissue* respiration. The lungs and the skin mediate between the air and the blood and lymph. The blood and the lymph are carriers between the respiratory organs and the living tissues. Charged with oxygen in the lungs, the blood is sent throughout the body, and everywhere in the capillaries it courses among living cells that require oxygen. The oxyhæmoglobin is robbed of its contained gas and becomes reduced, while the blood changes to a purplish colour. The cells, on the other hand, are constantly giving off carbonic acid, and this by diffusion passes readily into the blood. The lymph has in tissue respiration a function analogous to that which it has in tissue nourishment: it is the mediator between the blood and the living cells. Hence the result of tissue respiration as regards the blood is exactly the reverse of that of pulmonary respiration. The respiratory relations of the pulmonary and the systemic circulatory systems hence appear in a new and striking light. The former deals with the respiratory needs of the body as a whole, the latter with the respiratory needs of the living particles of which the body is composed.

Internal Respiration.

In considering respiration we have unavoidably touched upon the excretion of one waste product—carbonic acid. The other wastes may now be studied.

Section IV.

EXCRETION.

Leaving for the present the consideration of their sources, we may enumerate the chief waste products of protoplasmic activity as follows:

Waste Products.		Organs of Excretion.
Gaseous	Carbonic acid.	Lungs, skin.
Liquid	Water.	Kidneys, lungs, skin.
Solid	Urea and other nitrogenous wastes.	Kidneys, skin.
	Inorganic salts.	Kidneys, skin.

Protoplasm is unable to extract energy from these substances, and their presence in the body in excessive quantities is harmful. Nature has therefore evolved in the organs of excretion refined mechanisms for removing them from the organism. They are cast out from the living cells into the blood, and are transferred by the circulatory organs to the organs of excretion. The latter will now be considered.

A. THE KIDNEYS.

The kidneys are the most highly specialized of the excretory organs. Their duty is to manufacture and pass out the *urine*. Urine is a clear yellow or brownish-yellow liquid, consisting of about 96·5 per cent. of water and 3·5 per cent. of dissolved solid substances. The solids are numerous, comprising organic bodies such as urea, uric acid, and creatinin, and inorganic salts such as various sulphates, phosphates, and chlorides. Their variety and relatively considerable quantity indicate the great importance of the kidneys as purifiers of the blood and thus of the body. The greatest interest centres in the organic solids, of which urea is the most abundant, because they represent the characteristic waste products of the destruction of the important proteid substance. The special peculiarity of urea and these other products is the presence within them of nitrogen; hence the urine is the medium through which the all-important nitrogen leaves the body. The average quantity of urine that is passed in twenty-four hours is one and a half quarts, but the quantity is subject to great variations, depending upon the weather, the character of the food, whether much water has been drunk, and the occupation of the individual.

Urine.

The kidneys are highly complicated glands whose structure is specially adapted to the removal from the blood of large quantities of water, together with solid substances. They consist of a mass of minute canals (the *uriniferous tubules*), and of blood capillaries, inextricably woven together. Each tubule begins in an enlarged cavity (the *Malpighian*

capsule) into which projects a tuft of capillaries, the *glomerulus*. From the capsule the tubule takes a tortuous course, as shown in the accompanying figure (Fig. 11), unites with other tubules, and finally approaches the surface of the kidney, where, together with all the other tubules, it opens into the dilated, funnel-shaped beginning of the duct, the *ureter* (Fig. 12). The wall of the tubule consists of a single layer of living cells varying in thickness in

Structure of the Kidneys.

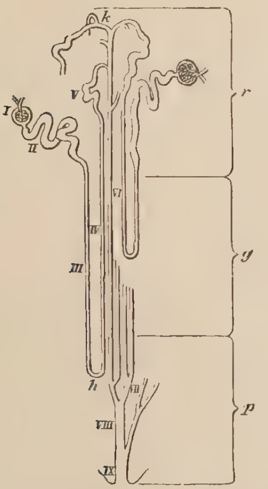

FIG. 11.—DIAGRAMMATIC VIEW OF COURSE OF URINIFEROUS TUBULES IN KIDNEY.

I, Malpighian capsule, containing glomerulus; *II–VIII*, course of tubule; *IX*, opening of tubule into pelvis of kidney at apex of pyramid of Malpighi; *k*, outer surface of kidney; *r*, outer or cortical substance; *g*, *p*, inner or medullary substance. (Huxley.)

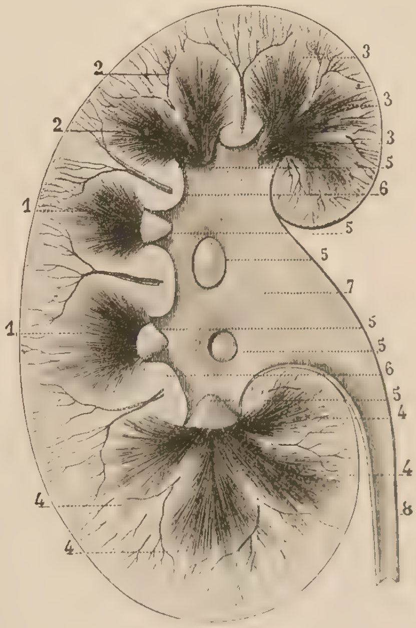

FIG. 12.—VERTICAL SECTION OF KIDNEY. (Somewhat smaller than natural size.)

1, 2, 3, 4, pyramids of Malpighi, striations representing uriniferous tubules; 5, apices of pyramids, where tubules open; 6, cortical substance projecting inward between pyramids and containing blood-vessels; 7, dilated end of ureter, called pelvis; 8, ureter. (Sappey.)

different parts. In among the tubules is the very close network of blood capillaries, and lymph permeates all the interstices. The tubules are thus bathed by the circulating fluids.

Most of the constituents of the urine exist ready formed in the blood, having been cast into it by the cells outside of the kidney. The process of excretion consists in a discharge of these substances through the cells that form the walls of the tubules. Some of the cells apparently have the power of manufacturing and casting out the few constituents that are not present in the blood. In its mode of action the kidney thus seems to combine the more

Excretion by the Kidneys.

clearly physical features of the work of lung cells and the more obscure secretory activities of gland cells, as represented by the digestive glands. The urine is secreted constantly, and trickles along the tubules to the dilated end of the ureter; it then leaves the kidney in the latter tube and passes to the urinary bladder situated in the pelvis. Here it accumulates until the distention of the bladder gives rise to a desire to micturate. Nervous impulses from the brain cause the muscular walls of the bladder to contract, and the urine is discharged from the body through the urethra.

B. THE SKIN.

The skin performs a variety of duties. It protects the delicate parts within the body; it contains organs for the senses of touch and of temperature; through its blood-vessels it regulates the temperature of the body; and it contains important excretory organs. The latter are the two kinds of glands known as *sudoriferous*, or *sweat*, glands and *sebaceous* glands; the former produce the sweat, the latter the oily substance found on the surface of the body.

Functions of the Skin.

Sweat glands are simple tubes the secreting portion of which, coiled into a knot, lies just beneath the skin (Fig. 13). The duct passes through the skin and terminates by a minute opening upon the surface. These "pores" may readily be seen by a common magnifying glass upon the fine ridges in the palm of the hand (Fig. 14). Sweat is a colourless, salty liquid

Fig. 13.—Vertical section of skin. (Magnified 20 diameters.)
1, outer layer of skin; 1, 2, cuticle or epidermis; 3, 4, inner layer of skin or dermis; 5, subcutaneous tissue; 6, sweat glands; 7, masses of fat, consisting of fat cells; 8, 9, ducts of sweat glands. (Sappey.)

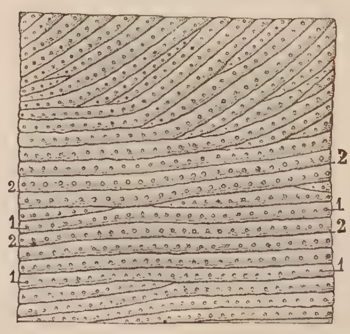

Fig. 14.—Surface of palm of hand. (Magnified 4 diameters.)
2, ridges in skin bearing (1) openings of ducts of sweat glands. (Sappey.)

consisting of water and slight quantities of urea, inorganic salts (especially common salt), and a few other substances. It is constantly given off. An average quantity is nearly a quart in twenty-four hours, but the amount varies greatly with the weather, the occupation of the individual, and other influences. The perspiration is thus seen to be an important medium of loss of substance from the body. This is especially evident when one exercises vigorously; it is easily possible in an hour's exercise to diminish one's weight by a pound. The more one perspires, the less the kidneys excrete, and *vice versa*. Hence the skin is more active in summer, the kidneys in winter.

Sweat Glands.

The sebaceous glands lie in the deeper part of the skin and open chiefly into the depressions in which lie the roots of the hairs. They secrete an oily substance of slight value as an excretion, but of use in preventing the skin and the hair from becoming too dry.

Sebaceous Glands.

C. THE LUNGS.

The expired air is an important medium of loss of water and the chief one for loss of carbonic acid. The excretory function of the lungs has been considered sufficiently under respiration.

We have followed the oxygen and the food—consisting of proteids, fats, carbohydrates, salts, and water—from without the body by way of the digestive organs and the lungs to the living cells. We have seen that waste matters in the forms of carbonic acid, urea, salts, and water go from the living cells by way of the excretory organs to the exterior. What takes place within the living substance?

Section V.

METABOLISM.

If we could answer the question propounded at the end of the last section we should know what life is; yet we are unable to point to any one of the millions of cells in the human body and say that we know all the details of the vital process that takes place within it. The difficulties and complexities of the problem are inconceivably great, but perhaps not insurmountable. We can measure and analyze the income and the outgo of the body; we can test the effect of different foods upon the general metabolism; we can observe how the composition of the different organs changes when food is withheld from the animal for a time, all of which methods are helpful. But, further than this, chemical investigation is revealing to us ever more clearly the steps in the pathway between food and wastes;

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we are approaching a knowledge of the structure of protoplasm and of the structural changes that take place in the actively working cell; and recent studies of the action upon organisms of the environment and of external agents—such as light, heat, electricity, and chemical influences—are giving us a deeper insight into the secrets of the physical basis of life. We can conceive the nutritional changes that take place within the cells and that constitute the metabolic process as consisting of a building up and a breaking down. Raw material in the form of food that is rich in energy is brought to and absorbed by the cells. It is altered chemically, its atoms are recombined, and it is built up, probably by a complex series of steps, into protoplasm, its energy being retained in a latent form; this is the constructive phase of metabolism, called *anabolism.* Later, the protoplasm is changed chemically, its atoms are recombined, and it is broken down, probably by a complex series of steps, into wastes, its energy being given off in the form of mechanical work and of heat; this is the destructive phase of metabolism, called *katabolism.* Stated in these words, the vital process seems simple enough. But this is not the whole story; for, in the first place, not all the food is built up into protoplasm before it is broken down into wastes; some appears to be changed at once after entering the tissues and to be immediately cast out in the excretions; other food is stored up for a time, to be used subsequently for the manufacture of protoplasm or for other needs of the body. Fat is an excellent example of a substance that is thus stored; it is not living, but is contained within special living cells—the fat cells. The cells of the liver are likewise loaded with a variety of starch, called glycogen. Fat and glycogen constitute a stock of reserve material upon which the cells may draw in time of need. Further, each of the different varieties of cells has its own special metabolic peculiarities. For example, the digestive glands are peculiar in manufacturing in quantity substances (the digestive fluids) that are of the greatest subsequent value to the body; certain of the brain cells are unique in the fact that their activity is accompanied by phenomena of thought; the muscles seem to be the greatest producers of the body heat. All these peculiarities complicate the problem of metabolism greatly, and the real difficulty comes when we attempt to learn the details of the matter.

Metabolism in General.

The one fact that stands out above all others is the fact that the destructive or katabolic process is one of oxidation; that is, the gas, oxygen, is made to unite with the other elements—carbon, hydrogen, nitrogen, etc.—that exist in the food or in protoplasm. Thus, of the various excreted substances, carbonic acid is a compound of oxygen and carbon (in the proportions CO_2); water is a compound of oxygen and hydrogen (in the pro-

Katabolism is Oxidation.

portions H_2O) ; and urea, while more complex in composition (CH_4N_2O), is undoubtedly formed by oxidative processes from the still more complex proteids. In this vital process of oxidation heat and mechanical energy are set free for the body's use, hence the body is warm and can do work; and the excretory substances are therefore largely devoid of energy. Oxidation is nothing more nor less than combustion; the burning of wood or coal or illuminating gas is oxidation. The burning of these lifeless substances, therefore, and the vital processes, are fundamentally of the same chemical nature. So, too, as regards energy, coal, when burned in a furnace, yields heat, mechanical work, and light; protoplasm, when consumed in a living body, yields heat, mechanical work, and in certain animals, such as the firefly, glowworm, and some marine forms, even brilliant light. Such a parallelism between lifeless and living substance is interesting and suggestive.

Anabolism not Simple Absorption.

Another striking fact is that the living tissues do not convert unchanged into their own substance the substance of the corresponding tissues that are eaten in animal food. For example, the fat of the food does not go directly to form the fat of the body; the muscle proteid of beef or mutton that we eat does not form directly our own muscles, nor does the animal starch—glycogen—come directly from the starch of bread and vegetables. On the contrary, all of the food stuffs are worked over by the living substance, are resolved into other substances, and these other substances are recombined into the proteids, the fats, and the carbohydrates that are found in living matter. One practical application of this principle is found in the fact that the most certain method of increasing one's weight by fattening is not by eating large quantities of fat, but rather by living largely upon a carbohydrate diet (starch and sugar), since it has been found by experiment that such a diet leads directly to the formation of body fat. On the other hand, to reduce the fat of one's body, a diet rich in proteid is most effective.

Nutritive Uses of Various Food Stuffs.

As to the uses of the various food stuffs, it may be said that proteid in some form is always necessary in the food, since it alone of the chief food stuffs contains nitrogen, and nitrogen is an important constituent of protoplasm. Proteid is the chief source of the elements of new protoplasm, and hence the value of meats, eggs, and milk as articles of diet. Proteid also gives energy to the body, but it is an expensive food. Fat is very rich in energy, and protects the proteid substance within the protoplasm from destruction. It may with advantage take the place of some of the proteid in the food; "a streak of fat and a streak of lean" is not without physiological justification. Carbohydrates play a rôle similar to the fats in supplying energy. They are a cheaper food and are easily digested. The part that is played

in metabolism by inorganic salts, of which common table salt may be taken as the type, is not known. They exist in all the tissues, and they are constantly leaving the body in the urine and the sweat. Depriving animals of salt brings on weakness and even paralysis; yet most salts are not sources of energy. All that is known upon the subject may be summed up in the statement that protoplasm will not continue to do its work without salt. Hence salt is needed in the food to balance the loss through the excreta and thus to maintain a constant supply in the living substance. Nor is water a source of energy. Its presence everywhere in the body facilitates the chemical reactions, and all substances in passing from one part of the organism to another must be dissolved in it. It constantly leaves the body, partly for the purpose of regulating the body temperature, as we shall see later, and partly for the purpose of carrying off the solid part of the excreta. Without it protoplasm dies, and hence its necessity in the food.

Diet.

Much attention has been given to the determination of a diet most suitable for the average man, and it is now known with reasonable accuracy what such a man requires for his daily needs. A fair division of the various food stuffs is given below:

Proteids	4 oz.
Fats	2 oz.
Carbohydrates	17 oz.
Salt	1 oz.
Water	nearly 3 qts.

It is not a simple matter, however, to proceed from such a diet to the preparation of a suitable *menu*, for, although the proportions of food stuffs in the common foods are known (Fig. 15), it does not follow that all the food stuffs taken into the mouth are absorbed by the tissues. The digestibility of the foods is an important factor too often overlooked by rich and poor alike. A liberal allowance of beefsteak will not yield to the body four ounces of proteid unless it be so prepared that the digestive organs can deal with it. The digestibility of the various foods has not yet been determined with sufficient accuracy; the problem is a difficult one, complicated as it is by the idiosyncrasies of individuals and by the infinite varieties of method used in the preparation of foods.

Vegetarianism.

Scientific investigation and the common experience of mankind point to a combination of animal and vegetable foods as the most suitable diet. Meat and eggs are especially characterized by the presence of proteid in a concentrated form; to obtain the needed amount of proteid from vegetables would require the consumption of an excessively large quantity of food. A strictly vegetarian diet throws upon the digestive organs of man an excessive amount of labour.

This is not so in the case of herbivorous animals, since in them the teeth are specially modified for grinding, the alimentary canal is relatively long and large, and the digestive processes are adapted to their tasks. In man, however, the teeth are evidently degenerating, and the alimentary canal is becoming reduced in capacity, the evident outcome of which in time

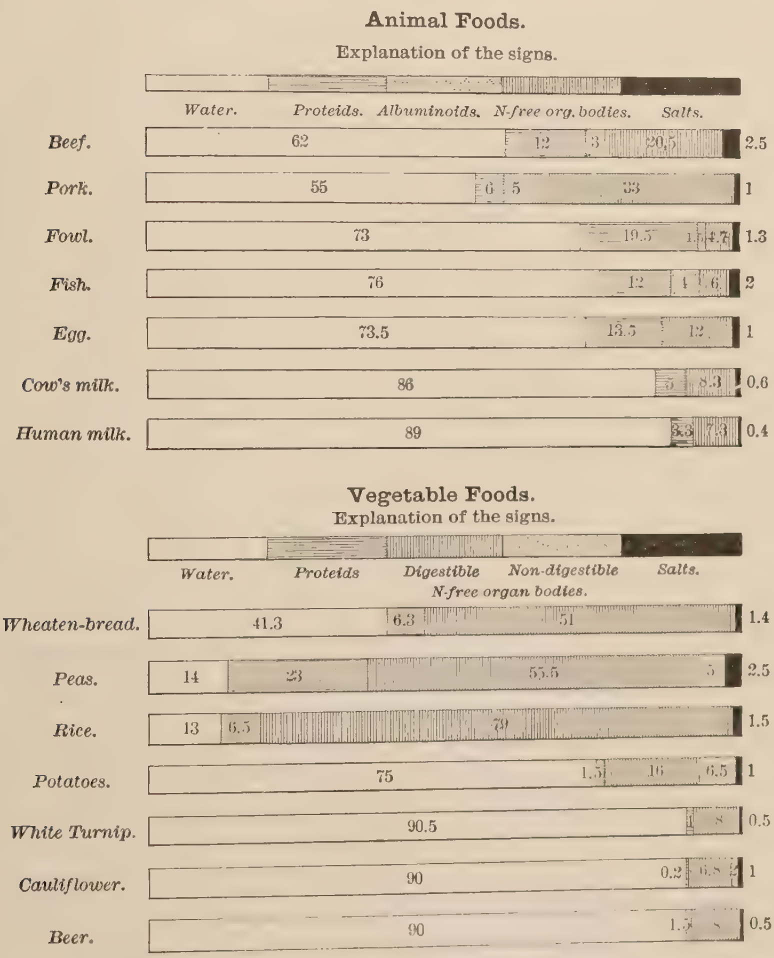

FIG. 15.—COMPOSITION OF SOME COMMON FOODS.
Nitrogen-free organic bodies include both fats and carbohydrates.

will be the necessity of less bulky, more easily masticated, and more easily digested food. The misguided vegetarians, in their endeavours to make man herbivorous, forget that that stage in his career was passed ages ago, that his body is no longer fitted for it, either anatomically or physiologically, and that stemming or turning back the tide of evolution is not without difficulties.

The two chief modes of manifestation of the energy of the body are through mechanical work and through heat. These may now be considered. Mechanical work is performed by the muscles, and comprises all work done by the hands and arms, by the legs in walking, by the trunk in lifting, by the larynx in speaking, etc. It is comparatively easy to measure approximately the amount of work performed by a man in a given task. It was supposed formerly that the energy for muscular work was derived solely from the nitrogen-containing proteid of the food and of the tissues. If this were so, and since urea is produced by the destruction of proteid, the quantity of urea given off from the body would be proportional to the amount of work done. Elaborate investigations made upon the pedestrian Weston, and other individuals, in order to test the question, have refuted the old idea and have shown that the main source of the energy of muscular work is not the proteids, but rather the fats and the carbohydrates. The hunger that follows labour does not, therefore, require for its satisfaction an increase of expensive proteid food. About one fifth of the total energy introduced into the body by the food appears again in the form of mechanical work, the remaining four fifths taking the form of heat. At first thought this would seem to indicate that the muscle is a poorly constructed machine. But a steam engine is able to employ for work only about one tenth of the total energy of the coal, the heat that is lost carrying off the other nine tenths. The human body as a machine for transforming energy is, therefore, much superior to the steam engine.

Energy of Mechanical Work.

Perhaps no fact in all human physiology is more striking than that the body of man is warm, and constantly warm during all seasons, even though the surrounding temperature may be excessively low. In this respect man is like all the mammals and birds and differs from all other animals. The terms "warm-blooded" and "cold-blooded" tell a part of the truth only; "warm-bodied" and "cold-bodied" are equally applicable. Yet a still more correct designation of the two classes of animals is that of *constant* temperature and of *changeable* temperature. An adult man's body has a temperature of about 98·6° Fahr., and normally varies rarely more than a degree above or below that point. A frog's body can not be said to possess a normal temperature. It is always cold to the touch, but varies within very wide limits, depending upon the temperature of the surrounding air or water. Heat is produced in all animal and plant bodies, but is dissipated at once to the surroundings in all organisms except the warm-blooded animals. The heat comes from the oxidation or burning of the food and body substance, and is derived from all three chief classes of food stuffs. Its production is a fundamental property of protoplasm, and takes place wherever living substance exists. Hence all organs and tissues yield heat; but the muscles, form-

Body Temperature.

ing as they do so large a proportion of the bulk of the body and being actively metabolic organs, are the greatest heat producers. The more active an organ is, the hotter it becomes. The blood, while producing little heat, performs the indispensable rôle of equalizing the body temperature. Receiving its own warmth from the tissues through which it courses, it warms the more sluggish parts, and in turn cools those whose temperature tends to become dangerously high. While heat is produced constantly, it is as constantly being lost. We warm our clothing and whatever we come in contact with that is of a lower temperature than the body; the air that we breathe out is warm; the excretions are warm; much latent heat goes off in the evaporating sweat. Of all these pathways of loss, the skin is the chief one, eighty per cent. of the lost heat leaving the body through it.

Regulation of Body Temperature.

As has been seen, a warm-blooded animal differs from a cold-blooded animal in the fact that the temperature of the body of the latter changes with that of the surroundings, while that of the former remains practically constant. The cause of this difference lies in the fact that in the warm-blooded organism both the production and the loss of heat are carefully controlled by the nervous system. As regards production of heat, the lower the temperature of the air the more heat the body produces, partly through invisible, obscure metabolism, partly through visible muscular movements, such as shivering; on the other hand, the higher the surrounding temperature, the less active are the muscles. As regards loss of heat, the lower the temperature of the air, the less blood goes to the skin, and hence the less heat radiates from the surface; on the contrary, the higher the temperature of the air, the more the cutaneous vessels dilate and allow the heat of the blood to pass off; at the same time the body perspires and gives out abundant latent heat in the sweat. Thus the vaso-motor nerves, the secretory nerves of the sudoriferous glands, and other nerves are employed for heat regulation, and their various activities are brought into harmony through the central nervous system. In the cold-blooded organism no such regulating mechanism exists.

Functions of the Liver.

In discussing metabolism the liver must not be overlooked, since it plays so important and such various rôles in nutrition. We shall here enumerate its chief functions. The liver produces bile, the use of which in the digestion of fats we have discussed. In addition to this digestive property bile contains several complex substances which must be regarded as waste products of protoplasmic activity, and are passed off from the body with the undigested food matters; hence the liver is an organ of excretion. The liver cells contain abundant glycogen, or animal starch, which is regarded as a reserve stock; hence the liver is a storehouse of carbohydrates.

Lastly, the liver seems to be the chief organ in which take place the final processes in the manufacture of urea; the raw material for excretion comes in the blood from the various organs to the hepatic cells, the cells transform them, and the finished product, urea, is transferred to the kidneys for elimination. With such a multiplicity of functions it is not surprising that "liver complaints" form so large a proportion of human ills.

The spleen, the thyroid body, the suprarenal bodies, and the thymus have apparently important metabolic functions, but their exact rôles are little known. At present they are being actively studied.

Our story of nutrition is completed. It is but the preliminary to a study of what may be called by some the higher functions of the body. To these we now turn.

CHAPTER II.

MOTION.

SECTION I.

MUSCLE IN GENERAL.

Motion in General.

NEXT to producing heat, the chief mode in which the body employs its stock of energy is by doing mechanical work. The physical sign of mechanical work is motion. Its manifestation is most evident in the day labourer. But the professional man and those who are known technically as brain workers are not simply heat producers. Aside from the ordinarily invisible involuntary movements of the organs and the visible voluntary movements of the body, without which no man passes through each succeeding twenty-four hours, the man who thinks gives his thoughts to the world in writing or speaking or acting, all of which are processes of movement. The organs of mechanical work are the muscles. A muscle is made up of muscle tissue and this in turn of muscle cells. Muscle cells always have one axis considerably longer than the other two, from which fact they are often called fibres, and the essence of their activity consists in their power of contracting or shortening in the direction of the long axis; in this process movement of attached parts is caused. This power of contractility is one of the fundamental attributes of protoplasm; it is possessed by the living parts of plants and by the one-celled animals. As the evolution of animal life in past ages went on and one-celled animals gave rise to many-celled animals with a variety of functions, the ability to contract became progressively stronger in some cells than in others.

In these contractile structure and function went on developing together, they became more and more perfected as organs of movement, and they gave rise finally to the highly specialized muscle cells that organisms possess to-day.

Structure and Varieties of Muscle.

When we look over the whole animal kingdom we recognise a very great variety of muscle tissue, from the simple cells of the jelly fishes, where only a part of the cell can be called muscular, to the highly differentiated muscle fibres of actively moving organs like the wings and legs of insects and the limbs of the higher animals. Notwithstanding this variety, muscle cells, especially in man and other vertebrates, may be grouped into three chief classes that are distinguished from each other both structurally and functionally. These are known, respectively, as *smooth*, *striped*, and *cardiac* muscle cells or fibres. *Smooth* or *unstriped* muscle fibres are so called because, in distinction from the other two varieties, they are not cross-striped (Fig. 16). They are usually spindle-shaped ; they are most common in tubular organs, occurring in the walls of the alimentary canal, the arteries and the veins, the ducts of glands, the trachea, and in general in those parts of the body, except the heart, that are capable of involuntary movement only. They are bound together by connective tissue into muscular coats encircling the tubes in whose walls they lie, and by their contraction they constrict the tubular organs. They are not under the control of the will. They are the most primitive of the three kinds of muscle substance. Their action is slow, as is indicated by the writhing, wavelike movements of the stomach and the intestine during digestion. *Striated* or *striped* muscle fibres are so-called because, when examined with the microscope, they appear indistinctly cross-striped with alternate lighter and darker bands (Fig. 17). They are very long, delicate, threadlike cells, and their protoplasm is highly complicated in structure. They are usually under the control of the will, and form the flesh or meat of the body, that is, the muscles of the arms, the legs, the head, and the trunk. Each muscle consists of a mass of innumerable fibres bound together by connective tissue into bundles, and is attached usually to bones by means of tendons. Striped muscle is the most highly specialized kind of muscle tissue. It is capable of very quick action, as is shown by the rapidity with which one can strike a blow or play a piano. *Cardiac* muscle is intermediate

FIG. 16.—UNSTRIPED MUSCLE FIBRES OF MAN. (Magnified 200 diameters.)

1, nuclei of fibres; 2, fibres in mass; 3, isolated fibres; 4, 4, two fibres joined together at 5. (Sappey.)

structurally between the other two. It consists of short, compact, indistinctly striped cells. It occurs only in the heart, and, as we have learned in studying the heart beat, contracts spontaneously, involuntarily, and rhythmically.

For the past fifty years muscle has been a fascinating and fruitful field of physiological research. Many of the most interesting and fundamental problems of general protoplasmic action have been and may be studied here more successfully than in other tissues; not only the laws of vital movement, but fundamental questions such as automaticity, irritability, rhythm, animal electricity, and the chemical phenomena of life. A large variety of delicate and valuable apparatus has been devised for the exact investigation of these various problems. The study of striped muscle has yielded the most information, and our present discussion will be limited to this. As has been stated, the essence of muscular action consists in the power of the muscle fibres to contract. In cold-blooded animals, such as the frog, the muscles retain their contractile power—that is, remain living—long after the animal has been killed, hence it is easy in such animals to study muscular action. During life the muscles are made to contract through impulses coming to them along the nerves from the brain or spinal cord. After death in cold-blooded animals they may be stimulated to activity by electric shocks, heat, pinching, or by certain chemicals applied either to the muscles directly or to their nerves. For each stimulation the muscle gives a single twitch or contraction, during which it shortens and becomes thicker and harder, and then immediately relaxes into its former state. The whole period of activity occupies only about one tenth of a second, yet during this moment the muscle undergoes profound molecular changes. Besides the mechanical changes spoken of, it produces heat and becomes warmer, produces carbonic and lactic acids, and develops a considerable electric current. All these phenomena indicate what great metabolic changes muscle protoplasm is subjected to during activity. It would be interesting to trace these further, but it would take us beyond our present space. In life it is probable that voluntary muscle rarely, if ever, gives

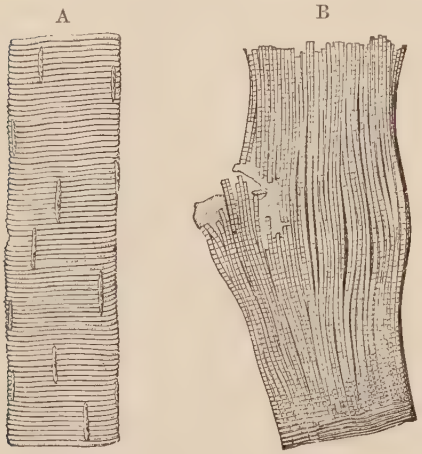

FIG. 17.—STRIPED MUSCLE FIBRES. (Magnified 250 diameters.)
A, piece of a fibre showing cross-striations and nuclei; B, piece of a fibre with cell-wall (sarcolemma) ruptured, showing tendency of fibre to split into fibrillæ. (Sappey.)

Action of Muscle.

single isolated twitches. Each contraction, however quick, consists of numerous single contractions following one another at the rate of about twelve in the second, and becoming fused into a compound contraction called *tetanus*. These rapid contractions give rise to a dull booming sound which is emitted by the muscle and may readily be heard by inserting the tips of one's fingers into the ears and contracting strongly the muscles of the arms. In health the muscles always seem to be in a state of slight contraction, or "tone," which accounts in great part probably for the elasticity, springiness, and ready muscular response of the athlete. This healthy tone appears to be due to nervous impulses coming constantly to the muscles from the spinal cord. It is noticeably absent in ill health. Many muscles are so placed as to antagonize the actions of others. For example, the flexors, which bend the arms, legs, fingers, and toes, act in opposition to the extensors which straighten the same parts; the eye is closed by the orbicularis and opened by its antagonist, the levator of the upper lid; and the delicate adjustments of the parts of the larynx in speaking and singing are due to refined balancing of opposing muscles.

Muscular Tone.

Section II.

SPECIAL MUSCULAR MECHANISMS.

As instances of special motor phenomena we have already mentioned the digestive movements, the beat of the heart, arterial constriction and dilation, and the movements of respiration. We may now notice briefly a few others.

A. LOCOMOTION.

The erect posture in standing or sitting requires the co-ordinated action of numerous muscles of the trunk and the legs. That this is so is evident from the fact that the body collapses whenever, as in fainting, the muscles fail to receive their customary stimulating impulses from the central nervous system.

Walking is a complicated muscular act, participated in by a large number of muscles of the legs, the trunk and the arms, that contract in regular sequence (Fig. 18). Each leg is flexed as it is swung forward like a pendulum; it is then straightened and serves as a support for the swinging trunk. The movements of the trunk are peculiar. It alternately rises and sinks, in falling forward, and sways from side to side as the centre of gravity of the body comes now over the right, now over the left foot; at no time is the body wholly free from contact with the ground, and for a brief interval, when the feet are farthest apart, both feet touch it at the same time. In running, the sequence of events is so

far different from that in walking that at one time the body is entirely free from support. The recent advances in the art of instantaneous

FIG. 18.—SERIES OF FIGURES FROM INSTANTANEOUS PHOTOGRAPHS TO ILLUSTRATE MOVEMENTS IN SLOW WALKING.

All phases of movement of the right arm and leg are shown in figures I to VI. Arabic numerals indicate the corresponding positions of the left arm and leg; thus position III of the right side is simultaneous with position 6 of the left side. (Marey.)

photography have added much to our knowledge of the mechanism of bodily movements.

B. FACIAL EXPRESSION.

Changes in facial expression are muscular phenomena, due to contraction of the facial muscles in combinations varying with the various emotions. This is shown by the fact that it is easy by electrical stimulation of the muscles through the skin to produce artificially in an individual at will a desired emotional expression (Fig. 19). The anatomical peculiarities of the face constitute the features and give a certain set to every countenance. The expressions are physiological, and are produced in much the same manner in different individuals. In his book, entitled *The Expression of the Emotions in Man and Animals*, Darwin has given the results of a careful study of expression. He analyzes into their various muscular components the changes accompanying joy, grief, despair, love, hatred, anger, disdain, contempt, pride, surprise, fear, horror, etc. He finds the origin of many of these expressions in the lower animals, and shows how they have gradually become habitual and

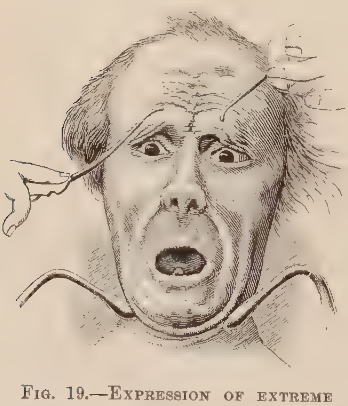

FIG. 19.—EXPRESSION OF EXTREME TERROR.

Produced artificially by stimulating with electricity the muscles of the forehead and the jaws. The four curved rods are the stimulating electrodes laid upon the skin over the muscles. (From Darwin, after Duchenne.)

innate in man. Their primary purpose was not to reveal emotional states of mind, but rather they were either of some direct bodily benefit to the

FIG. 20.—EXPRESSION OF VARIOUS EMOTIONS, SHOWING CHARACTERISTIC MUSCULAR CONTRACTIONS.
A, pride and defiance; B, helplessness; C, childish joy; D, childish grief. (A and B from Darwin after Duchenne.)

individual or were indirectly the effect of a general excitement of the nervous system. (See Fig. 20.)

C. VOICE.

The production of voice is the most delicate of all muscular acts of which the human body is capable. The larynx, the organ of voice, is the modified upper end of the trachea. However much the voice may seem to arise at the lips, or in the mouth, or in the chest, it is only modified by these parts, and the sound is produced in the larynx only. Considered as a musical instrument, the larynx is most nearly like a reed instrument, of which the clarionet is an example; but the resemblance is not close. In the larynx the parts that correspond to the reeds, by the vibration of which voice is produced, are the two vocal cords (Fig. 22). They are elastic membranes that extend from each side horizontally toward each other into the cavity of the hollow larynx, and are stretched more or less from before backward. They do not meet in the middle line, but have between them a chink of variable width, the glottis, extending across the larynx from front to back. Each cord is thickened with muscle at its outer part attached to the walls, but its free edge at the glottis is thin, and consists of white, tough, elastic connective tissue. Thus the air-passage to and from the lungs is obstructed at its upper end by this horizontal membranous partition, with a passageway for air between its two halves. During ordinary silent breathing this obstruction is slight, for then the vocal cords recede to the side walls of the larynx and the glottis is wide open. During speaking or singing the cords are extended in toward each other and the glottis is reduced to a mere slit.

Physiological Anatomy of the Larynx.

Voice is the sound produced by the rapid vibration of the thin edges of the cords as the air rushes between them in expiration. The essential conditions of the production of voice are that the cords must be taut and their edges must be approximately parallel. These conditions are fulfilled through the various delicate muscles acting upon the cartilages to which the cords are attached, or even upon the cords directly.

Conditions of Voice.

The natural pitch of a voice depends upon the natural length and tension of the cords. Variations in pitch are produced by varying either the degree of tension or the length of the vibrating cord, or by varying both together. Thus, for the low tones, the more tightly the cords are stretched the higher the note, just as is the case in tuning a violin. For the high tones, the cords do not usually vibrate along their whole length; a portion, usually the posterior, is "stopped" by the cords being brought into contact with each other, and the anterior part only is capable of acting (Fig. 22, B), just as in playing the violin the pitch is regulated by placing the finger upon the string. Loudness of voice is determined by the strength

Pitch, Loudness, and Quality.

of the outgoing current of air. The quality of the voice—that by which we distinguish one voice from another and recognise the voices of our friends—depends upon the make and the age of the individual larynx, its size, the quality of the cords, and the shape, the size, and the mutual relations of the accessory vocal organs, such as the mouth and its parts, the nose, the pharynx, and the chest; in like manner the quality of tone

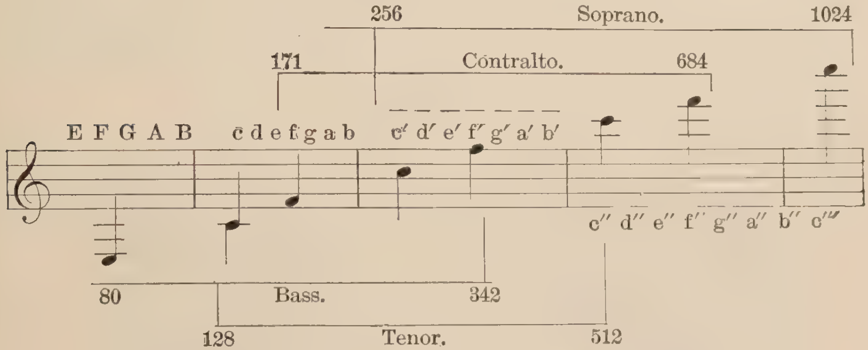

Fig. 21.—The average range of human voices.
c′ to f′ is common to all voices. The figures indicate the number of vibrations per second in the corresponding tones. (Landois and Stirling.)

of a violin depends upon age, the peculiarities of the grain of its wood, and the shape, size, and connections of the various parts of the instrument.

Control of the Voice.

The muscular adjustments necessary in producing all the wonderful variations in tone and in quality of which the human voice is capable are inconceivably delicate. Not only the muscles of the larynx, but those of the various accessory vocal organs, the tongue, the lips, the palate, and the pharynx, and the respiratory muscles, contribute their share in the process. All of these muscles are under the most careful nervous control, and, as we shall see later, a particular area of the brain has as its special duty the management of the vocal organs. The training of the voice is a training of these nervous and muscular mechanisms. That which determines whether a voice shall be called soprano, contralto, tenor, or bass, is partly the natural length of the vocal cords and partly the general nature of the vocal mechanism. The average range of the individual voice is two to two and a half octaves; the relative pitches of the four kinds of voice are shown in the accompanying table (Fig. 21).

Vocal Registers.

In singing a scale we are conscious of the necessity at certain notes of rearranging our vocal organs if we wish to produce well-rounded tones and prevent the voice from breaking. Such adjustments take place at different notes for different individuals. The compass that is possible for each adjustment constitutes

the so-called "register." Vocal teachers detect several registers, but physiologists recognise commonly two—the chest register or voice, and the head register or voice. The former, employed for low notes, is characterized by richness and fulness of tone; the latter, employed for high notes, is thinner. The difference in the mechanism of the two is not fully understood, and is perhaps not the same for all individuals. The appearance of the vocal cords during the production of voice, as shown by the laryngoscope (a small mirror placed in the back of the mouth and reflecting a bright light down into the larynx), is presented in the accom-

Fig. 22.—Interior of larynx, as seen by laryngoscope, during production of (A) chest-voice (Mandl and Grützner), (B) head-voice (Mills).

The glottis is represented as a black longitudinal slit in the middle of the figures, long in A, short in B; the vocal cords are shaded in A, white in B; the curved body at the upper part of the figures is the epiglottis; the rounded elevations at the lower part of the figures are cartilages.

panying figure (Fig. 22). The mechanism of the falsetto voice in man is also in dispute. The breaking of the voice in boys at puberty is caused by the rapid growth of the larynx and the constant congested condition of the vocal cords.

Speech.

Speech is voice modified by changes in the accessory vocal organs, especially the resonance cavities, the pharynx, the nasal cavities, and the mouth. The sounds of speech are classified into vowels and consonants. All vowels have the same laryngeal sound as their basis; but for each vowel, by changes in the shape of the resonance cavities, different overtones are added to the fundamental laryngeal tone, hence the difference in the sounds. Consonants are noises produced mainly in the mouth by modifications of the outgoing current of air. Some are and some are not accompanied by vocal sounds. In gutturals (K, G) the modification is produced by the soft palate and the root of the tongue; in dentals (T, D, S, L, Z, N, R) by the tip of the tongue near the teeth; in labials (P, B, F, V, M) by the lips. The details of the mechanisms of the consonants must be omitted.

Section III.

NON-MUSCULAR MOTOR MECHANISMS.

Muscle is not the only motor tissue that is found in the human body. There are two other varieties of contractile cells that in a very unostentatious way perform mechanical work and are indispensable to the body's welfare. These are amœboid cells and ciliated cells.

Amœboid Cells.

Amœboid cells comprise the colourless corpuscles of blood and of lymph (Fig. 4, G), and are so called because they resemble and are capable of moving about from place to place like the simple one-celled animal, *Amœba.* Reference has already been made to their function.

Ciliated Cells.

Ciliated cells are epithelial cells, and are fixed in position with one end exposed to the cavity which they line. This uncovered end bears a tuft of minute, delicate, hairlike filaments (the cilia) that project into the cavity (Fig. 1, E). During life the cilia are in constant, rapid, wavelike motion, sweeping along whatever substances come in contact with them. They are especially useful in carrying from the lungs toward the mouth and the nose mucus, and with it inhaled particles of dust. They line not only the bronchial tubes, the trachea, the larynx, and the nasal cavities, but the ducts of certain other organs, and, being in incessant action throughout the lifetime, they accomplish a large amount of labour.

CHAPTER III.

THE NERVOUS SYSTEM.

Nervous System in General.

It would be a sorry community of people wherein every individual worked for himself alone, regardless of the wants and the welfare of others, and wherein there existed between individuals and between professions no social and no commercial intercourse. A continuance of such a state of things would be impossible unless the community were composed of few individuals and such as were content to remain low in the scale of civilization. The same principles apply to a community of protoplasmic cells and organs; if there be no intercellular and no interorganic comity and exchange there is no rising in the scale of organisms. We have seen that in the human body the mutual interactions of the various parts are excessively complex, and this complexity is carried so far that no part is able to live when separated from the body. In both the community of people

and the organic community an agent is needed to control the relations of individuals. Such an agent exists in the system of government of the one and the nervous system of the other. In every body of men that has taken rank above the lowest a government exists, while in every protoplasmic animal organism above the simplest there is a nervous system. The subordinate position in the organic world that is accorded to plants is due more than all else to their lack of nervous organs. The nervous system is at once the servant and the master of all the other systems; it responds to the needs of one by controlling the work of another; thus it coordinates and harmonizes, and makes one of many. But it attends not only to internal affairs: it keeps the organism apprised of what goes on without, and thus enables the body to adapt itself to its environment. It is, finally, the medium of all mental life. To accomplish all this it must of necessity be complicated both in its anatomy and in its mode of working. No system in the body is more complicated. None is more difficult to investigate and to understand. The nervous system of man comprises the central nervous system, consisting of the brain and the spinal cord, and the peripheral nervous system, consisting of the nerves and the ganglia. A portion of the peripheral system is known as the sympathetic system, though this can not be regarded as physiologically independent of the rest. To this enumeration must be added the organs of the special senses; these are so unique as to justify treatment in a separate chapter. The different parts of the nervous system have very different structures and functions, such that the whole may be regarded as a union of numerous complex organs; but notwithstanding the complexity, the elements of structure

FIG. 23.—DIAGRAM OF A TYPICAL NEURON. *b*, cell body; *d*, dendrites, or protoplasmic processes; *a*, axis-cylinder process, or nerve fibre.

and of function are fundamentally the same throughout all parts. Within the past ten years remarkable advances in our knowledge of nervous structures have been made.

Elements of Nervous Structure.

The elements of nervous structure are the nerve cells, or *neurons*, as they are now coming to be called. Neurons vary in shape, but each consists of a cell body and processes extending from it (Fig. 23). The cell body consists of protoplasm and a large nucleus. The processes may be of two kinds, called *dendrites*, or *protoplasmic processes*, and *axis-cylinder processes*. The dendrites are much-branched, short filaments. The axis-cylinder process, usually one in number for each cell, is the most highly specialized part of the neuron. It has few branches, and may be very long (three to four feet). Near its end it splits into numerous fine filaments that terminate in the vicinity of the cells supplied by the neuron, whether they be muscle cells, gland cells, sense cells, or other neurons. The brain and the spinal cord are masses of neurons bound together by connective tissue and richly permeated by blood-vessels. It was formerly supposed that the processes are joined together into an inextricable network, and that nervous impulses, in passing from one part of the nervous system to another, traverse this maze. But recent discoveries have made it reasonably certain that there is no network whatever; that, on the other hand, every neuron is independent of every other, and that a nervous impulse passes from one to another through contact, and not through continuity of their respective processes. In some parts of the brain and the spinal cord cell bodies and dendrites predominate and constitute the *gray matter;* in other parts axis-cylinder processes only exist, constituting the *white matter*. Nervous ganglia are masses of cell bodies. Nerves are bundles of axis-cylinder processes arranged parallel to each other, each process being ensheathed usually in a fatty covering called the medullary sheath. The axis-cylinder process

FIG. 24.—PSYCHIC BRAIN CELLS IN DIFFERENT STAGES OF EVOLUTION.

A, frog; B, newt; C, mouse; D, man. Series *a* to *e* shows the stages that a single brain cell of a higher vertebrate passes through in its growth. (Baker, after Ramón y Cajal.)

and its protecting sheath form a *nerve fibre*, and every nerve is composed of numerous nerve fibres. In the embryo nerve cells arise as compact bodies. The processes appear as outgrowths from them, and continue to grow in length and complexity during embryonic life and adolescence. It is a significant fact that the neurons are more complex the higher they are in the animal scale (Fig. 24).

Elements of Nervous Function.

The elements of nervous function comprise the functions of the body of the neuron and those of the processes. The cell body is the central organ of nervous energy. It receives, originates, and gives out nervous impulses. In most neurons the activity of the cell body is wholly unconscious, but in those existing in the superficial layers, the cortex of the cerebrum, mental phenomena accompany the nervous actions, hence such neurons are called *psychic*. The processes of the nerve cell are specialized to conduct nerve impulses, the dendrites conducting probably toward the cell body, the axis-cylinder process in some cells away from, in others toward, the cell body. Nerve cells are usually said to act either automatically or reflexly. An *automatic* action is one in which the impulse originates in the cell body as the result of chemical or other changes, and passes thence along the axis-cylinder process to the end organ (Fig. 25). The respiratory centre is said to act automatically. The psychic cells are called automatic. It is a question whether automatism in this sense is at all a common phenomenon. A *reflex* action is one in which the nervous impulse originates outside of the nerve cell, passes to the latter, is there elaborated, and then passes on as before to the end organ (Fig. 25). A typical example of a reflex action is that of winking: a foreign body touches the eyelashes or the eyeball; this causes nervous impulses to go to the nerve cells that control the muscles of the lids; return impulses

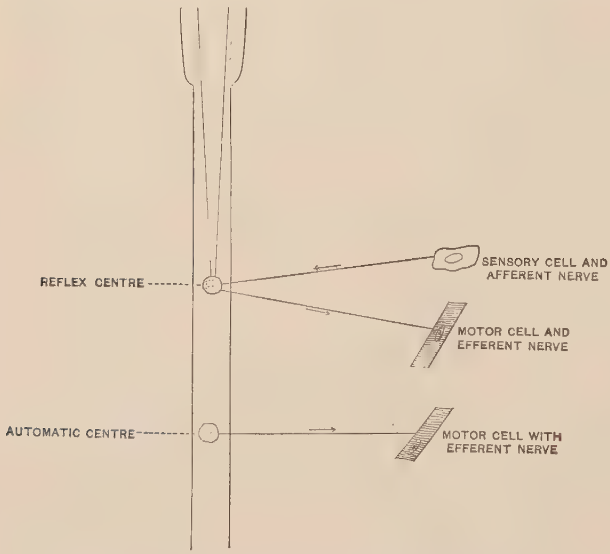

Fig. 25.—Diagram to illustrate nervous mechanism in (1) automatic action, (2) reflex action, (3) passage of sensory impulse upward and of motor impulse downward within central nervous system. (Mills.)

come back to the muscles, and the lids close. Reflex actions are involuntary. The greater part of the body's actions are reflex; not only the unconscious movements that we are making constantly by means of our skeletal muscles, but also the muscular movements of the viscera and secretion in glands. The term "reflex arc" signifies the anatomical apparatus required for a reflex action. It consists of (1) a sensory end organ; (2) an afferent nerve fibre; (3) its associated nerve-cell body; (4) a second nerve-cell body in functional connection with (3), and giving rise to (5) an efferent nerve fibre; (6) a motor end organ, usually a muscle.

Nerve Centres and Nerve Conductors.

Thus we see that, physiologically, the nervous system consists of innumerable nerve centres and nerve conductors. The bodies of the nerve cells are the centres; the processes, especially the axis-cylinder processes, are the conductors. Considered *en masse* and roughly, the gray matter of the central nervous system and the ganglia outside of it have the functions of centres; the white matter of the central nervous system and the nerves are conducting in function. No fibre conducts in more than one direction. The nerve fibres outside of the brain and the spinal cord may be divided into two great classes, according as they conduct impulses toward the central nervous system or away from it; accordingly, they are known either as *centripetal* or *afferent*, or as *centrifugal* or *efferent* fibres. Most nerves are composed of both kinds. In the case of the spinal nerves a separation of the two kinds takes place at the junction of the nerve and the spinal cord, such that the posterior or dorsal root consists of afferent, the anterior or ventral root of efferent fibres. An afferent impulse, upon arriving at its centre, may simply give rise at once to an unconscious efferent impulse, producing a reflex action, or, with or without doing this, it may pass upward to the brain and give rise to a sensation (Figs. 25 and 26). Correspondingly, an efferent impulse may either arise in a lower reflex centre, as the direct result of an afferent impulse, or it may arise high up, even in the psychic part of the brain, and pass downward and outward, giving rise to a voluntary act. Hence, in harmony with the classification of peripheral fibres into afferent and efferent, there occurs within the brain and the cord a distinction between such fibres as conduct upward toward the cerebrum and such as conduct downward from the cerebrum. The former are really paths for the continuation of the afferent impulses coming

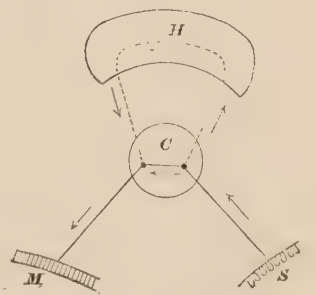

Fig. 26.—Diagram intended to show the relations of the brain, the spinal cord, and the peripheral organs.

S, sensory end organ; *C*, spinal cord; *M*, motor end organ (muscle); *H*, hemisphere of brain. (James.)

from the outside to the psychic cells, where the impulses may give rise to sensations; hence afferent nerve fibres and those that conduct upward within the brain and the spinal cord are often called *sensory*. On the other hand, the downward impulses within the central nervous system are destined in large part for the muscles, and pass to them along the efferent nerve fibres, hence such conducting paths are called *motor*. The same terms apply to the cell bodies which the fibres join. The distinction between sensory cells and motor cells, sensory fibres and motor fibres, sensory centres and motor centres, and sensation and motion as nervous functions, is one of the most fundamental distinctions in the physiology of the nervous system. It is a curious and as yet not explained fact that the sensory parts of the brain and the spinal cord lie, in general, dorsal or posterior to the motor parts.

Sensory and Motor.

We have now presented the elements of nervous action. The central nervous system is a collection of central stations for the receipt, transformation, and transmission of nervous energy. Each of these stations has its own specific function, but they are joined with each other in the most intricate manner, and they are continually modifying each other's work. In ascending from the lower to the higher parts of the nervous system there is a progressive correlation of functions and a supervision of the lower by the higher centres. At the top in the cortex of the cerebrum lie the psychic cells, which are the physical media of mental life, the seat of the sensations and the place of origin of voluntary acts, and which are able to control the acts of all the lower centres (Fig. 26). To this elaborate mechanism stream constantly through sensory nerves impulses from all parts of the body and from the organs of the special senses, giving information regarding the condition and the needs of the various organs and tissues and the occurrences of the outside world. The ultimate possible goal of these impulses is the cortex of the cerebrum, there to give rise to sensations. But very few of the impulses reach this goal. Those to which the attention is directed, those which are unusually or excessively strong, or which for other reasons require consideration by the mind, pass to the cortex. The great majority, however, are dealt with by the lower centres. Wherever the impulses terminate they act upon sensory centres; these in turn stimulate motor centres; and, largely as the result of the incoming stream, there is as constant an outgoing stream of motor and other impulses through efferent nerves to the tissues and the organs. These outgoing nervous impulses regulate the actions of the various parts and of the body as a whole. Let us now consider the parts of the central nervous system more in detail.

Summary of Nervous Action.

As we ascend through the series of vertebrate animals in the order,

fish, reptile, bird, mammal, man, we find that there is a progressive increase in the weight of the brain as compared with the weight of the body. This is shown in round numbers in the accompanying table (Waller):

Comparative Importance of Brain.

	Weight of brain.	Weight of body.
Fish	1	5,000
Reptile	1	1,500
Bird	1	220
Mammal	1	180
Orang-outang	1	120
Man	1	50

Moreover, there is a progressive increase in the size of the brain as compared with the spinal cord; within the brain there is a progressive increase in the size and complexity of the higher parts as compared with the lower; and, lastly, there is a progressive increase in the size and relative importance of the cerebral cortex. This last fact is to be correlated with the gradual evolution and perfecting of mind, while the facts together mean that in general there is a progressive subordination of lower to higher centres. Accordingly we find, in ascending the series, a gradual limiting of the work of the lower parts.

A fish or a frog will continue to live for days after the brain is wholly destroyed if the spinal cord be left intact. This is impossible in the case of man. The human spinal cord is pre-eminently the central nervous organ for the reflex actions in which the spinal nerves take part, hence for the actions of the limbs and the trunk (Fig. 27). The "tone" of the voluntary muscles depends upon it. It contains respiratory, vaso-motor, and other centres which are accessory to more powerful ones in the medulla oblongata. Obviously it is also the path of conduction of impulses between the spinal nerves and the brain. The majority of these impulses ascend and descend upon the side of the cord from which their nerves arise. A few cross over to the opposite side.

Spinal Cord.

The medulla oblongata and the rest of the brain stem contain the reflex centres of the cranial nerves and various other automatic or reflex centres; they regulate the movements of the eyes, the face, the tongue, the alimentary canal, the heart, respiration, the arteries, the larynx in speaking, the pharynx and œsophagus in swallowing; they also control the secretion of saliva and other digestive fluids. The brain stem serves also, like the spinal cord, as a path of upward and downward impulses. It is a curious fact that both sensory and motor impulses here cross over from one side of the brain to the other; hence the left side of the cerebrum deals with the right half of the body, and *vice versa.*

Brain Stem.

The function of the cerebellum is commonly believed to be that of harmonizing or co-ordinating the actions of the muscles. Injury to this part of the brain results in irregularity and uncertainty of bodily movements. But experimental evidence has not made it clear exactly how the organ acts.

Cerebellum.

Exact knowledge regarding the functions of the optic thalamus and the corpus striatum is quite wanting.

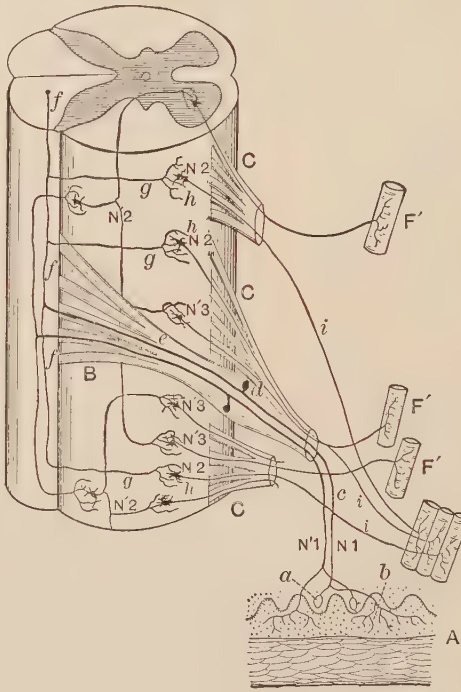

Fig. 27.—Diagram to illustrate reflex actions.

A, skin; F, F′, muscle fibres; large column at left represents a piece of the spinal cord with gray matter within and white matter without; B, dorsal nerve roots; C, ventral nerve roots; N 1, N′ 1, N 2, N′ 2, N 3, N′ 3, neurons. A simple reflex path comprises N 1 and N 2, which include origin of axis-cylinder process in end bulb (*a*) or between cells (*b*), afferent fibre (*c*, *e*) belonging to cell body (*d*), branches (*f*) giving off "collateral" branches (*g*) to terminate about N 2; cell body (*h*), efferent fibre (*i*) terminating upon muscle fibre (F). A compound reflex path comprises a similar collecting neuron, N′ 1, one or more correlating neurons, N′ 2, and distributing neurons, N′ 3. (Baker.)

Cortex of Cerebrum.

The cortex of the cerebrum is spoken of as the "seat" or the "organ" of consciousness and of intelligence; its cells form the physical basis of mental phenomena. When a man thinks, his cortical cells act; and if the latter be destroyed, mental phenomena seem to cease so far as that individual is concerned. We can only speculate as to the kind of relation that exists between the cerebral and the mental processes; so far as we know, the latter are always accompanied by the former. As experimental physiologists we search for the cerebral processes, and we find that apparently they do not differ from those that take place in any mass of nerve cells whose activity is unaccompanied by consciousness. Structurally the cortex is unique, being characterized by the presence of the large, much-branched pyramidal cells that occur nowhere else in the organism (Fig. 28); in details it differs in different parts. Formerly it was believed that the cortex acts as a whole, but modern research has shown the untenability of this view, which, indeed, seems now opposed to common sense.

In 1870 two German physiologists, Fritsch and Hitzig, found that if

the brain of a dog were exposed and the cortex stimulated in different places by electric shocks, contractions of the animal's muscles accompanied each stimulation, and the movements varied according to the particular cortical area that was touched.

Localization of Functions in the Cortex.

Since then investigation of the subject by various methods upon various animals and man has been active with the result that now localization of different functions in different parts of the cortex has become an accepted fact, although there is still considerable difference of opinion regarding the exact functions of different areas. The accompanying figures represent the opinions of authorities at present, but the details are subject to change by future investigation (Figs. 29 and 30). The most obvious principle regarding localization is that the motor area, which has the function of controlling through lower centres the actions of the various voluntary muscles, is situated in the middle part of the cortex, extending across the top of the brain; while the sensory area, which deals with the sensations arising from activity of the organs of the

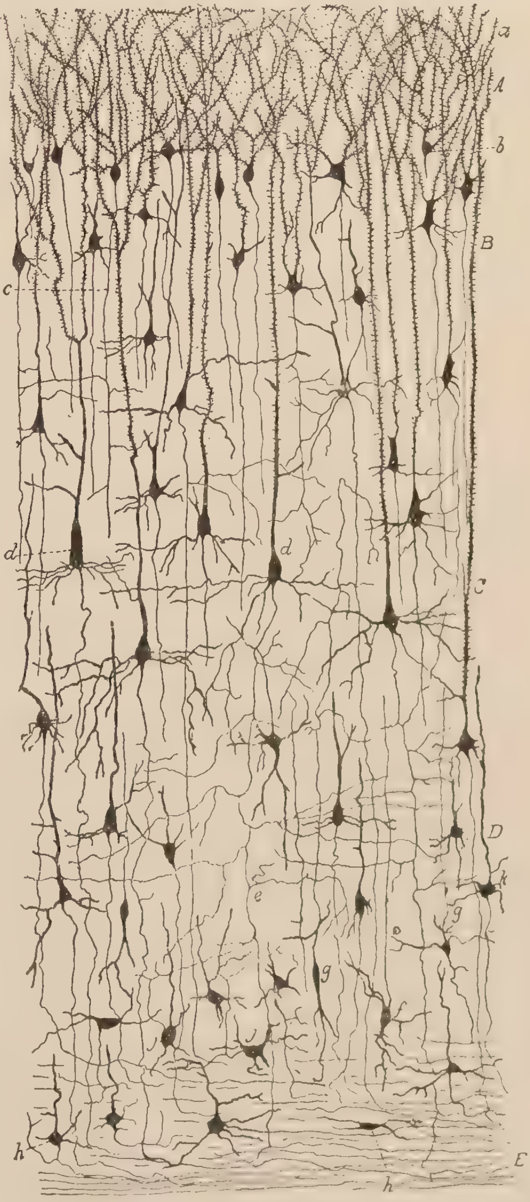

Fig. 28.—Section of the cerebral cortex of young mouse, showing psychic cells and their branches. *A–D*, various layers of cells; *E*, white matter; *a*, dendrites or protoplasmic processes; *c*, *e*, axis-cylinder processes; *b*, *d*, *f*, *g*, *h*, different types of cells. (Baker, after Ramón y Cajal.)

special senses and of the sensory nerves, lies farther back. The motor area lies in general on either side of the fissure of Rolando, and, as is

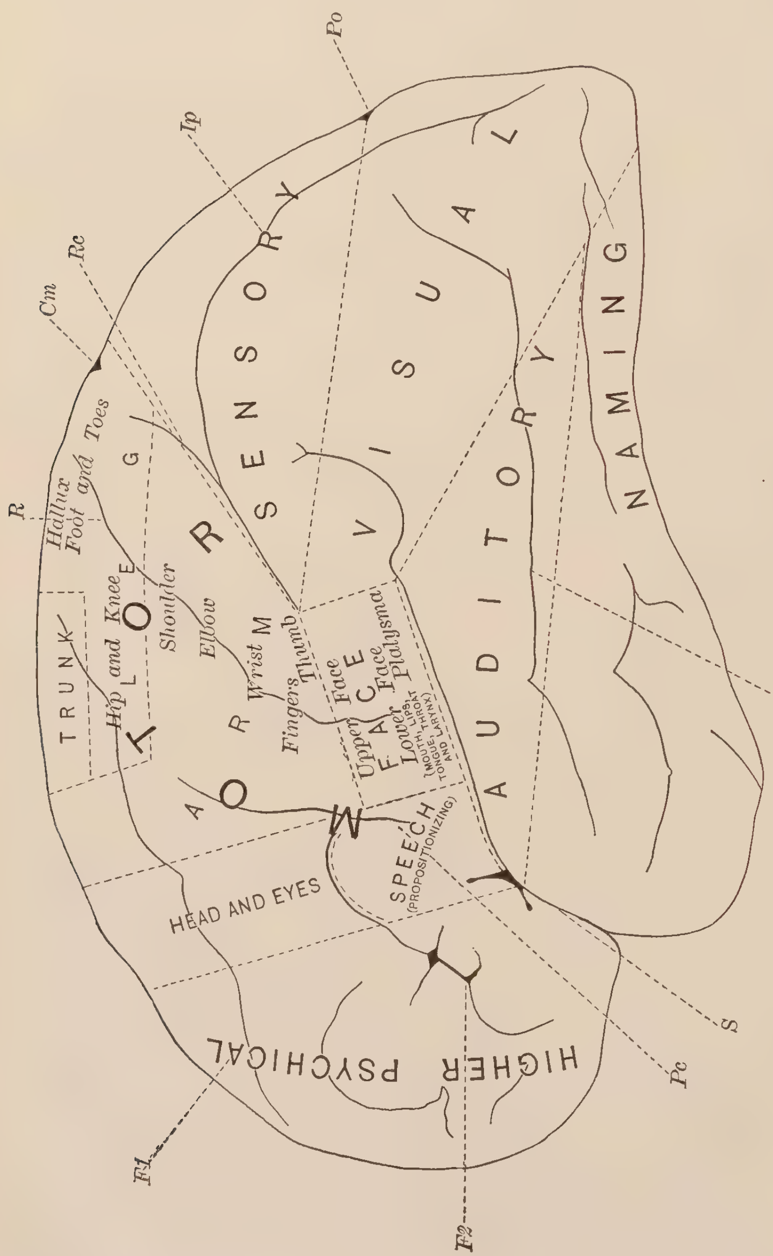

FIG. 29.—SIDE VIEW OF THE HUMAN BRAIN INTENDED TO SHOW THE POSITIONS OF VARIOUS NERVOUS CENTRES.
The area marked "motor" controls the movements of the designated parts of the body. The "sensory" area is believed to deal with sensations of touch. The "visual" area with sensations of sight, etc. Very little is known regarding the functions of the front parts of the brain, marked "higher psychical." (After C. K. Mills.)

seen in the figures, the centres for the actions of different groups of muscles have been localized. The centre marked speech is the motor

centre for the muscles of the organs of speech. In the living man it exists in the area a little behind and above the left temple. The

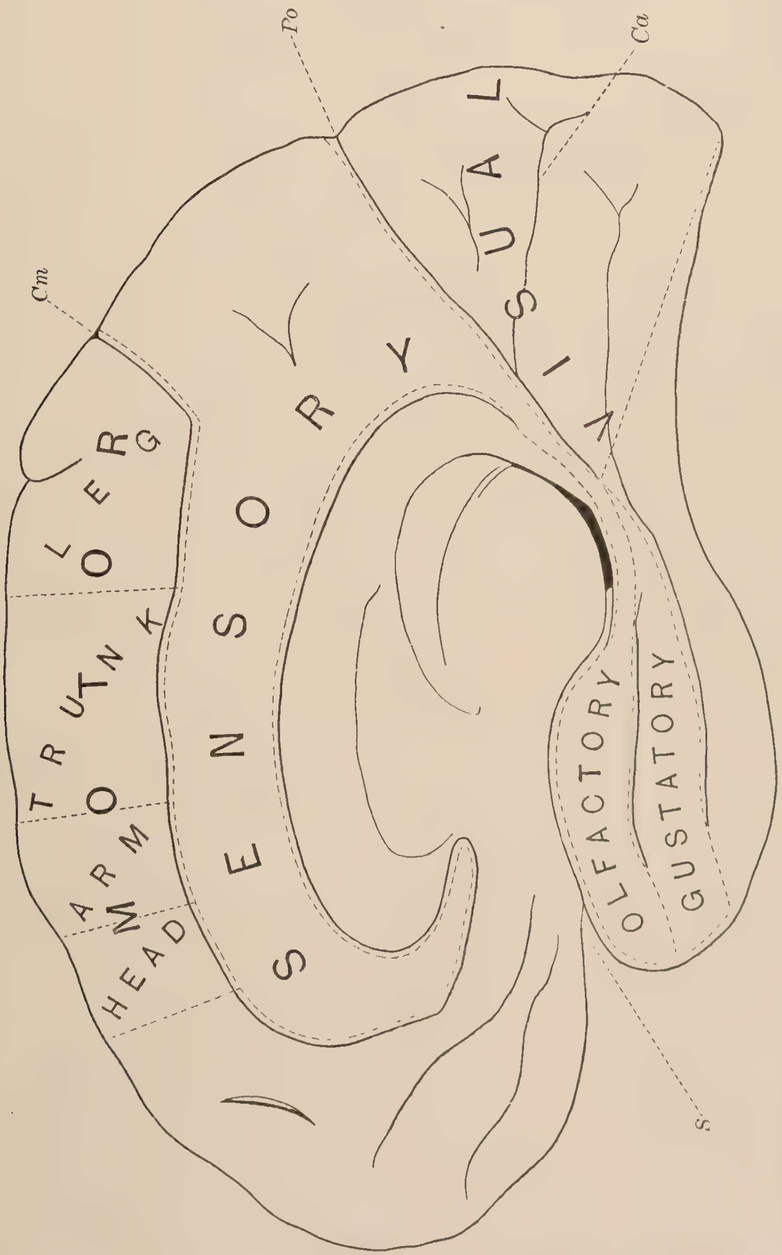

Fig. 30.—Median view of the human brain, intended to show the positions of various nervous centres not shown in Fig. 29. (After C. K. Mills.)

whole process of the understanding and the use of language is excessively complicated, involving many parts of the brain; a portion of

the nervous mechanism is represented in Fig. 31. Visual impulses (s'') from the printed words pass to the centre of sight (V); auditory impulses (a) from the spoken words pass to the centre of hearing (A); these centres are connected by "association" fibres with each other and with the motor centres for the arm, as used in writing (W), and for the vocal organs (E); when these muscles are employed, motor impulses (m', m) pass to them, while sensory impulses (s', s) inform the centres of what is going on. The various centres do not appear to be sharply marked off, but rather to overlap adjacent areas. Most of them exist upon both sides of the brain, and, as has been stated, each half of the brain controls the opposite side of the body. The right-handedness of most persons is due to the superiority and greater refinement of the left hemisphere of the brain over the right, and the reverse is true of left-handed individuals. Most persons are "left-brained speakers," since the speech centre is developed usually upon that side only.

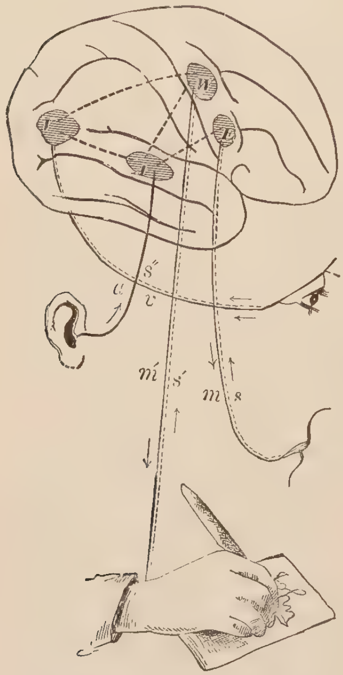

Fig. 31.—Diagram intended to show the nervous mechanism employed in the understanding and use of language (for description, see text). (James, after Ross.)

The functions of the frontal lobes of the cerebrum are quite unknown. The term "higher psychical," in Fig. 29, should be accepted with caution.

Psychical Processes.

We have not space here to go into a discussion of them, nor of the physical bases of the various psychical phenomena—the will, the feelings, attention, judgment, memory, etc. All such subjects are still in a very hypothetical stage.

The modern doctrine of localization recalls the older school of phrenology and proves how utterly unscientific and unfounded were the phrenological conceptions. Where the phrenologist located "hope" the scientific physiologist finds the nervous mechanism of locomotion; "inhabitiveness" and "self-esteem" marked the centres now known to be concerned in vision. A bump upon the skull does not necessarily imply a bump upon the brain; and the laboratory work of Fritsch and Hitzig relegated phrenology to the inevitable oblivion of empiricism.

Phrenology.

In discussing the nervous system we have tacitly assumed that the function of any one part is simply to stimulate some other part to act.

Suppression or inhibition of action is, however, widespread, and of almost equal importance. The best-known example of inhibition is that of the vagus nerve slowing or stopping the beat of the heart.

Inhibition.

Every individual knows how often in his conscious life he is compelled to say "No" to his impulsive self, and an objective study of his own nervous processes, if such were possible, would show him that one of the frequent tasks of his nerve cells is to prevent or put a stop to the actions of other nerve cells. Probably any act of the individual beyond the very simplest is the result of a combination of motor and inhibitory nervous influences. Consider the nervous processes as portrayed in the accompanying figure (Fig. 32). The baby sees the candle flame for the first time and instinctively tries to grasp it; the nerve paths of this simple reflex action are shown in 1, 1, 1, 1, from the eye to the visual centre, thence to the motor centre and to the muscles that extend the hand. The finger is burned, and a second reflex results in the withdrawal of the hand; 2, 2, 2, 2, marks the reflex arc, from the sensory nerve endings in the skin to the sensory centre, thence to the motor centre and to the muscles that withdraw the hand. But the cerebral centres are apprised of the occurrences, and the upgoing impulses arouse perceptions of ($s1$) the image of the flame, ($m1$) the action of extension, ($s2$) the pain, and ($m2$) the action of withdrawal. The groups of cells mediating the perceptions are "associated" by fibres, and retain in their physical structure the "memory" of the events. A few days later seeing the candle arouses again the unconscious impulse to seize it. But the cortical cells are now on the alert, inhibitory impulses are shot down to the motor centres, and the hand is withheld.

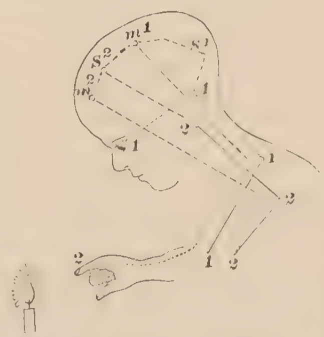

FIG. 32.—DIAGRAM INTENDED TO SHOW THE PATHS OF NERVOUS IMPULSES (for description, see text). (James.)

The nature of nervous impulses or nervous energy is not known. When nerve centres act, their protoplasm appears to undergo katabolic changes, to produce heat, to become fatigued, and thus to resemble other protoplasm in its general metabolic phenomena. Nerve fibres, however, are peculiar in that no evidences of katabolic changes are present in them during even long-continued passing of nerve impulses. The rate of transmission of impulses is not difficult to measure, and in man averages about one hundred feet in the second. A feeble electric current always accompanies the impulse, but the slow rate and other considerations seem to forbid the assumption that the impulse itself is electrical.

Nature of Nervous Energy.

Reaction Time.

During the past few years physiological psychologists have devoted much attention to the measurement of the time of cerebral processes—the time it takes to think. The basis of their investigations is the determination of the simple reaction time, which is the time that elapses between the giving of a stimulus—say sending an electric shock to the skin or light to the eye—and a signal made by the person to indicate that the stimulus is felt. The average reaction time—which, it is needless to say, varies greatly in different individuals—is between one tenth and two tenths of a second. It is shortest for touch, longest for sight, and for hearing it is intermediate between the other two (touch 0·14 seconds, hearing 0·16 seconds, sight 0·18 seconds). If the time required by the end organs and the nerves be subtracted from the whole interval between stimulation and reaction, there is left the time occupied by the brain itself in recognising the sensation and willing the motor response; this may be placed, in round numbers, at one tenth of a second. Practice and attention shorten the reaction time; fatigue and complication of the cerebral process (such as would be caused by offering the subject a choice between two kinds of stimulation) lengthen it.

CHAPTER IV.

SENSATION.

Sensations in General.

All parts of the body are supplied with sensory nerve fibres, and accordingly from all parts of the body impulses may go to the central nervous system and there give rise to sensations. Sensations are classified as either general or special. General sensations comprise those by which we recognise vaguely the existence and condition of the various parts of our bodies; bodily comfort and discomfort, fatigue and pain, are general sensations; all parts of the body seem to possess general sensibility. Special sensations comprise those that possess a more specific distinguishing quality than general sensations; they are mediated by specialized organs, which are confined to certain specific parts of the body. Formerly it was customary to recognise five classes of special sensations—namely, those of sight, hearing, taste, smell, and touch. Investigation has now shown that two others must be added to the list—namely, sensations of temperature and muscular sensations. The anatomical apparatus of each of the seven senses consists of (1) delicate end organs, which are adapted in each case to a special method of stimulation; (2) special afferent nerve fibres; (3)

special portions of the central nervous system which are the seat of the sensations. Of all the senses, sight has the most highly specialized organs, and may profitably be considered first.

Section I.

SIGHT.

The sense of sight arouses in us ideas of form, size, distance, light, shade, and colour. The end organs of sight are the eyes, which are adapted to stimulation by the vibrations of the ether that we call light; the afferent nerves are the optic nerves; and the seat of visual sensation is the cortex of the occipital lobes of the cerebrum.

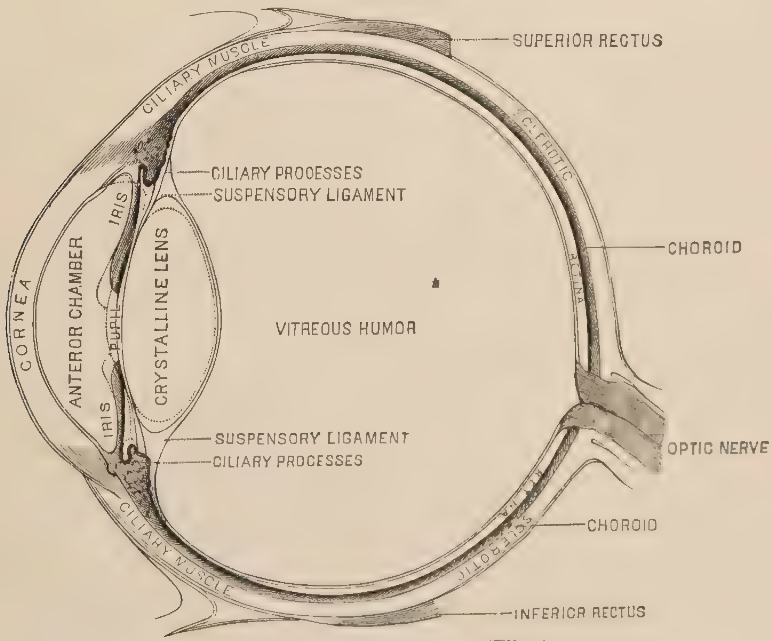

Fig. 33.—Section of the eyeball (Flint.)

Physiological Anatomy of the Eye.

Considered as a piece of physical apparatus, the eyeball is a camera obscura, of which the best-known example is the photographic camera—that is, it consists of a chamber with blackened walls. The back wall holds a sensitive plate, the *retina*, upon which an image of the object is thrown; the front wall is pierced by a hole, the *pupil*, about which is an adjustable diaphragm, the *iris;* and a system of transparent refractive bodies, or lenses, comprising the *aqueous humour*, the *crystalline lens*, and the *vitreous humour*, bring the rays of light to a focus upon the retina (Fig. 33). The

end to be reached is the stimulation of the nervous apparatus in the retina, and accordingly the retina is regarded as the essential part of the eye, all other parts being accessory.

Retina.

In its origin the retina is a part of the brain, which has grown out along the route of the optic nerve and has come to be located in the eyeball. It consists of nerve cells of different shapes, arranged in layers, as shown in the accompanying figures (Figs. 34 and 35), and bound together by supporting tissue. The significance of the various parts is not understood, but the terminal end

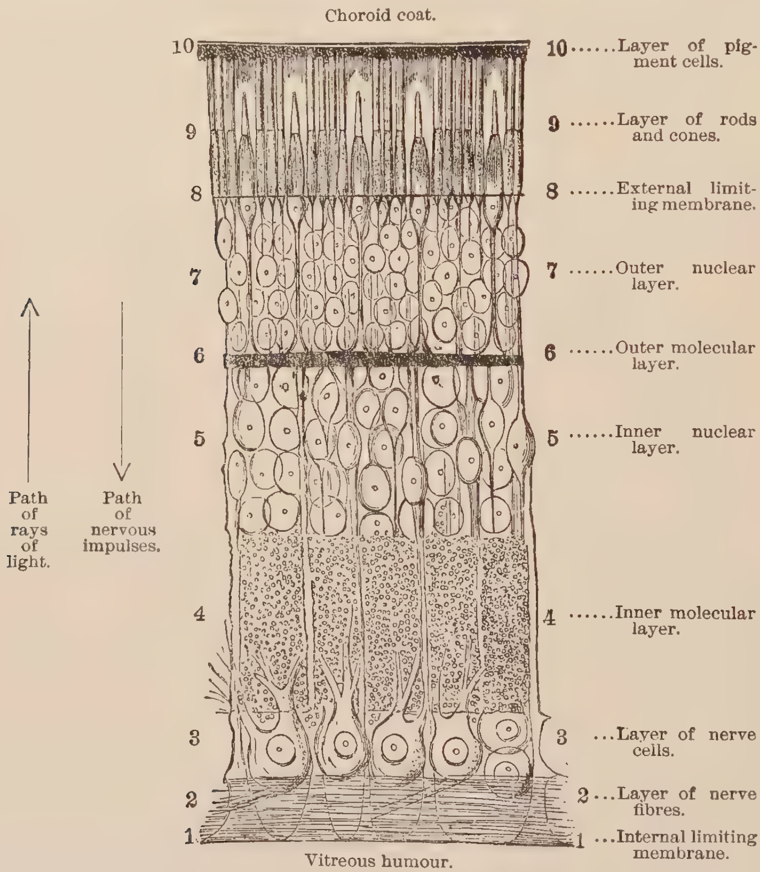

FIG. 34.—SECTION OF THE RETINA (DIAGRAMMATIC). (Schultze.)

organs of the nervous mechanism are the *rods* and the *cones*, which, through forming the outer layer of the retina, seem to be the parts that are sensitive to light, and upon which the image is focused. They consist of highly specialized protoplasm; their names and the figures indicate their shape. It is estimated that there are at least three million cones

and many more rods in each retina. The difference in function of the rods and the cones is not known. The light probably causes chemical changes in them, and thus originates nervous impulses; the latter traverse the various retinal layers of nerve cells and their processes, reach the optic nerve, and go thence to the brain. The retina may be stimulated mechanically by pressure upon the eyeball. Thus, rubbing the eyes, as is often done upon awaking from sleep, produces sensations of light in the form of points, spots, or circles. "Seeing stars," as the result of a blow, is due to mechanical stimulation of the retina.

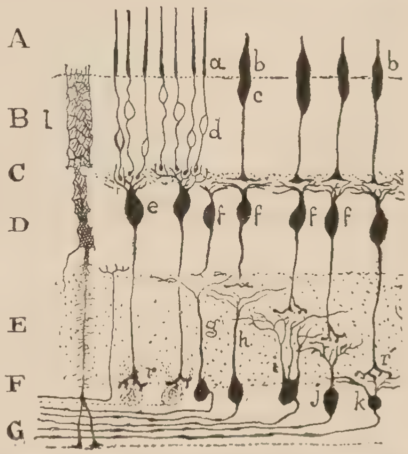

FIG. 35.—SECTION OF THE RETINA (DIAGRAMMATIC), INTENDED TO ILLUSTRATE THE RECENT DISCOVERIES AS TO THE STRUCTURE AND RELATIONS OF THE VARIOUS LAYERS.

A, layer of rods (*a*) and cones (*b*); *B*, outer nuclear layer; *c*, nucleus of cone; *d*, nucleus of rod; *C*, outer molecular layer; *D*, inner nuclear layer; *e*, rod bipolar cell; *f*, cone-bipolar cell; *E*, inner molecular layer; *F*, layer of nerve cells; *g*, *h*, *i*, *j*, *k*, nerve cells with processes branching at different levels; *G*, layer of nerve fibres; *l*, non-nervous supporting cell (fibre of Müller). (Ramón y Cajal).

After-images.

The effect upon the retina lasts frequently for a considerable time after the eye is turned away from the object. For example, a single look at the sun will enable us to see suns for several seconds afterward. Such an after-effect is termed an *after-image*. Sometimes, and especially at first, it is of the same colour as the object, but later it appears in the opposite or complementary colour; in the former case it is called positive, in the latter negative. Thus the after-image of a white object may be at first white, but later it is gray or black; of a red object, perhaps momentarily red but soon green. Positive after-images are due to a continuation of the nervous excitation after the cause of it is removed; negative after-images result from fatigue of the nervous mechanism for the colour that is looked at, hence the predominance of the complementary colour.

Blind Spot.

The place of entrance of the optic nerve into the retina, being devoid of rods and cones, and, in fact, of all nervous organs except nerve fibres, is insensitive to light, and is called the *blind spot*. Its blindness may be proved by the following simple experiment: If the left eye be closed and the circular disk in Fig. 36 be looked at with the right eye, it will be found that the cross is also visible, except when the book is held at a distance of from nine to twelve inches from the face; at that distance the image of the cross falls upon the end of the optic nerve and is not perceived. In ordinary life each eye cor-

rects the invisible spot in the field of the other, and hence we do not appreciate the two gaps in our combined field of vision.

FIG. 36.—DIAGRAM FOR DEMONSTRATING EXISTENCE OF BLIND SPOT.

Formation of Retinal Image.

The formation of the retinal image is a purely physical matter, and follows the laws of refraction of light. The rays of light from each portion of the object looked at are bent out of their course by the three refractive bodies, but chiefly by the crystalline lens, and are brought to a focus upon the layer of rods and cones. Thus a small inverted image of the object appears upon the retina exactly as upon the ground glass of the photographic camera (Fig. 37). As in all optical instruments, focusing is necessary in order that the picture may be sharp and distinct. By the curvature of the lens and the length of the eyeball the eye is focused normally for objects situated at a great distance from the observer. For nearer objects focusing might be brought about theoretically either by making the lens more convex or by increasing the length of the eyeball. In the camera the latter method is employed by drawing back the plate of ground glass. In the eye the retina can not be moved, and hence the curvature of the lens is altered in the following manner: The lens is elastic, and normally is kept slightly flattened by the tension of surrounding parts. When vision is directed to near objects the ciliary muscle, which lies just outside the edge of the lens, contracts and pulls forward the choroid coat together with the suspensory ligament of the lens. Tension on the lens being thus diminished, the latter bulges forward and becomes more convex (Fig. 38). Sharpness of the image is also assisted by shutting out the rays that would come through the more external parts of the lens. This is accomplished by the muscular diaphragm, the iris, which, in proportion to the nearness of the object, contracts and

Accommodation.

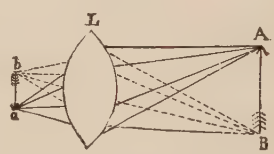

FIG. 37.—DIAGRAM ILLUSTRATING REFRACTION OF RAYS OF LIGHT AND FORMATION OF AN INVERTED IMAGE BY A LENS. *A B*, object; *L*, lens; *b a*, image. (Martin.)

diminishes the size of the pupil. Both the iris and the ciliary muscle are under nervous control, and their actions are delicately harmonized reflexly through the brain, the optic nerve being the afferent nerve.

Defects in Visual Apparatus.

Considered as an optical instrument, the human eye, although apparently so exactly adapted to its uses, is by no means perfect. Indeed, the distinguished German physicist and physiologist, Helmholtz, while admiring its surpassing fitness, once wrote of its shortcomings: "If an optician wanted to sell me an instrument which had all these defects, I should think myself quite justified in blaming his carelessness in the strongest terms, and giving him back his instrument." The eyeball may be too long (*near-sight*) or too short (*far-sight*); in both cases exact focusing for a wide range of vision is difficult, and, unless the eye is assisted by spectacle lenses, a blurred image falls upon the retina. The curvature of the front surface of the eyeball, the cornea, may be irregular, a very common defect known as *astigmatism*, which manifests itself also by a blurred image. The

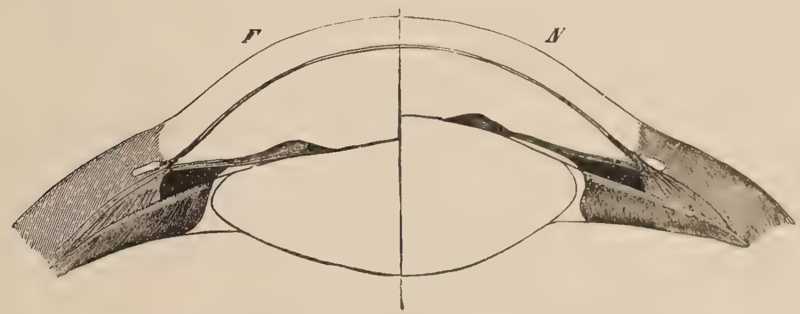

Fig. 38.—Diagram illustrating the mechanism of accommodation of the eye. In *N* the lens is accommodated for near objects; in *F*, for distant objects. (Fick.)

crystalline lens, like all lenses, produces some spherical and some chromatic aberration. Floating within the vitreous humour of all eyes are peculiar opaque particles, cells of irregular shape and filaments, that appear as mysterious moving particles in the field of vision; they are most evident when one gazes at a white wall or at the sky; they are entirely harmless. A considerable number of individuals suffer from colour blindness, which is apparently due to a lack of certain colour-perceiving elements in the retina and will be discussed hereafter. Lastly may be mentioned the trouble with vision that appears in most persons shortly after middle life (*old-sight*); it may be due to a weakening of the ciliary muscle or to a loss of elasticity of the crystalline lens.

The question as to how we see colour has been and still is the cause of much speculation, experimentation, and theorizing. Objectively one colour differs from another only in the length of the waves and the rapid-

ity of vibration of the ether; and white light is the resultant of a host of these different waves taking place simultaneously. By means of the spectroscope white light may be analyzed into seven colour groups, called "primary colours" viz.: red, orange, yellow, green, blue, indigo, and violet; and, since given these colours all colours whatsoever may be obtained by proper mixing, it follows that, if we can explain the perception of the primary colours, we can explain all colour vision. But the matter is simpler than this, for experiment shows that all colour sensations may be produced by proper mixing of three colours only instead of seven—*e. g.*, red, green, and violet. This fact is the basis of the common theory of colour vision, the Young-Helmholtz theory, which supposes the existence of three primary colour sensations, such as red, green, and violet, all other colour sensations being combinations of these. Perhaps these correspond to three kinds of material elements in the rods and cones or in other parts of the visual apparatus, each element being capable of stimulation by all colours of light, but more especially by one colour. Thus white light stimulates all three alike, red light the red-perceiving elements more strongly, and so on. Colour-blindness is due to a lack of at least one of the three kinds of elements—a red ribbon appears like a green ribbon because the red-perceiving elements are wanting. This theory accounts for many of the facts of colour vision, but is not entirely sufficient. Several other theories have been suggested and are being actively tested and discussed.

Colour Vision.

With some of the lower animals, such as the rabbit, every object is seen with one eye only; each eye has its own field of vision. Man, however, is a binocular animal, since under ordinary circumstances he directs his two eyes toward the object looked at. As a matter of fact, only the middle part of his field of vision is binocular, since the right eye alone sees to the extreme right, the left eye alone to the extreme left; the amount of overlapping of the right and the left fields in front depends upon the shape and the prominence of the nose. Slightly different pictures of the object looked at fall upon corresponding points in his two retinas, but out of the two images he receives a sensation of one object. Binocular vision is of the greatest value, since by it we are able to form much more exact ideas of distance, size, and form than by one eye alone. Binocular vision would be nearly valueless, however, were it not supplemented by the muscles of the eyeballs and their exact co-ordination by the central nervous system. These muscles rival those of the larynx in delicacy of action, and enable any point within the range of the two eyes to be turned to instantly. The newly born babe often possesses the primitive power of moving the eyes independently of each other, a power which adults rarely retain.

Binocular Vision.

The eyelids exist for the protection of the eyeballs. Winking, by sweeping across the ball and through the lachrymal canals into the nose the secretion of the lachrymal gland, serves to keep the surface of the cornea moist, and to wash away foreign particles that might be injurious to it. When the secretion becomes excessive, it overflows in the form of tears. Lachrymal glands arose in the course of evolution, when aquatic animals gave rise to those leading a terrestrial life. Hence fishes, whose eyes are bathed constantly by the surrounding water, neither require nor possess them, while they exist in all animals above fishes. The power of weeping, although it has been observed in elephants, some monkeys, and in a few other animals, is confined chiefly to man. Usually, but not always, it signifies grief or bodily suffering. Darwin believes that it arose incidentally as the result of a chain of events somewhat as follows: The suffering child, like the young of other animals, cries out, partly for aid from its parents, partly to relieve itself by activity; in this act the blood-vessels of the eyes are gorged with blood, and to prevent injury therefrom the muscles about the eyes are contracted strongly (see Fig. 20, B); the muscular contraction causes in some reflex way not wholly understood a flow of tears from the gland; in the adult all the events in the chain are not necessary, and grief leads directly to weeping.

Tears.

Section II.

HEARING.

The ear is the most complicated of all known sense organs. Its essential part comprises the nerve-endings in the membranous labyrinth of the internal ear; the accessory parts consist of the rest of the internal ear, the middle ear, and the external ear. In so far as the ear is used for hearing, it is adapted to receive the vibrations of air that we call sound and to transmit them to the nerve terminations. The diagram (Fig. 39) shows the relations of the various parts of the auditory organ. The pinna, or external part that we commonly call the ear, is omitted from the figure, but the passage (*E. M.*, *external auditory meatus*) is shown, and the arrow indicates the path of the waves of sound. The waves cause the tympanic membrane (*Ty. M.*) to vibrate, and this produces a gross movement of the delicate ear bones (*Mall.*, *Inc.*, *Stp.*) that stretch across the air-space of the middle ear (*Ty.*). The middle ear is seen to be really a drum with one drumhead (*Ty. M.*) upon one side, two drumheads (*F. o.*, *F. r.*) upon the opposite side, and a passage (*Eu.*) to the pharynx, and thus to the outside air, for the purpose, as in all drums, of equalizing

Physiological Anatomy of the Ear.

the pressure of air within and without. Through the membrane of the *fenestra ovalis* (*F. o.*) the liquid perilymph within the bony labyrinth (*Sca. V.*, *Sca. T.*) of the internal ear is set into vibration. The vibrations pass through the walls of the membranous labyrinth, affect the liquid endolymph, and stimulate the nerve-endings (*Sca. M.*). A more detailed but still diagrammatic figure of the membranous labyrinth is shown in Fig. 40. It is there seen that the labyrinth consists of three distinctive parts, viz.: two central irregular-shaped cavities (*utricle* and *saccule*) indirectly connected; three *semicircular canals* joining the utricle, each with an enlargement, the *ampulla*; and the *canal of the cochlea* (*Coch.*), joining the saccule. Each of the three distinctive parts contains in its walls characteristic nerve terminations; and, as the figure shows, there are in reality six end-organs within the ear. Of these it is probable that the nervous organ in the cochlea alone, the organ of Corti, is auditory in function.

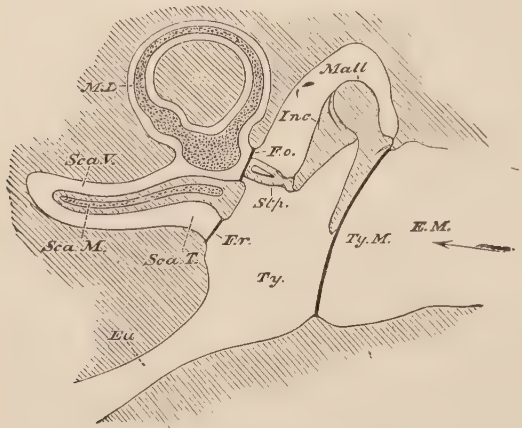

Fig. 39.—Diagram of ear.

The external ear comprises the external projecting part, or *pinna* (omitted from figure), and the *external auditory meatus* (*E. M.*); the arrow indicates the direction of the waves of sound. The middle ear or *tympanum* (*Ty.*) comprises the *tympanic membrane* (*Ty. M.*), the *fenestra ovalis* (*F. o.*), the *fenestra rotunda* (*F. r.*), the three bones, *malleus* (*Mall.*), *incus* (*Inc.*), and *stapes* (*Stp.*), and the Eustachian tube (*Eu.*); the middle ear is filled with air, and connects with the pharynx through *Eu.* The internal ear, or *labyrinth*, comprises the osseous labyrinth and the membranous labyrinth. Both are highly diagrammatic in figure, the former being reduced to *scala tympani* (*Sca. T.*) and *scala vestibuli* (*Sca. V.*) of cochlea, and one *semicircular canal*, the latter being reduced to *scala media* (*Sca. M.*) of cochlea, and one *semicircular canal* (*M. L.*); the osseous labyrinth is filled with perilymph, the membranous labyrinth with endolymph. All bony parts are shaded with oblique lines. (Huxley.)

The organ of Corti (Fig. 41) is a complex mechanism, resting upon one wall of the cochlear canal, the *basilar membrane*, and extending from the base to the apex of the cochlea. It consists of a succession of curious rodlike structures, the rods of Corti, beside which are columnar cells, tipped with hairs and surrounded by the terminations of the nerve fibres; the hairs pass through a perforated membrane (*reticulate membrane*), and over all is a curtain, the *tectorial membrane*. The hair-cells are the proper end-organs; they correspond in function to the rods and cones of the retina; through them the nerve fibres are stimulated. But the method of stimulation has not yet

Organ of Corti.

been satisfactorily determined. It will be remembered that the organ of Corti is bathed with endolymph and the bony labyrinth outside the cochlear canal is filled with perilymph, hence the vibrations caused by sound may be transmitted readily to the organ of Corti. It was formerly thought that the rods of Corti first received these vibrations, and that from them the nerves were stimulated. But it seems more reasonable to believe that the important part of the organ is the basilar membrane, which consists of parallel fibres extending from within outward, and which may act somewhat after the manner of the wire board of a piano.

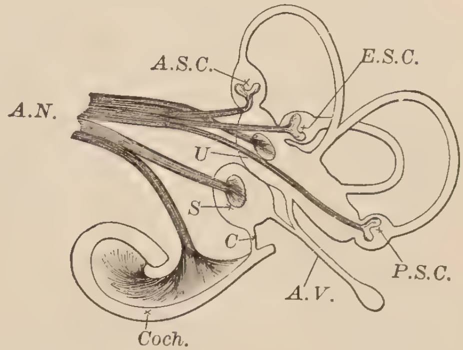

FIG. 40.—DIAGRAM OF MEMBRANOUS LABYRINTH AND DISTRIBUTION OF AUDITORY NERVE.

U, utricle; *A. S. C.*, *E. S. C.*, and *P. S. C.*, anterior, external, and posterior semicircular canals; *A. V.*, aquæductus vestibuli; *S.*, saccule; *C.*, canalis reuniens; *Coch.*, canal of cochlea, or scala media; *A. N.*, auditory nerve, dividing into six branches that end respectively in the three *cristæ acusticæ* of the ampullæ of the semicircular canals, the two *maculæ acusticæ* of the utricle and the saccule, and the organ of Corti in the cochlea. (Huxley.)

In discussing voice we spoke of pitch, quality, and loudness as three characteristics, the production of which was to be explained. A theory of hearing must explain the recognition of these three characteristics. According to the theory now usually adopted, the recognition of pitch depends upon

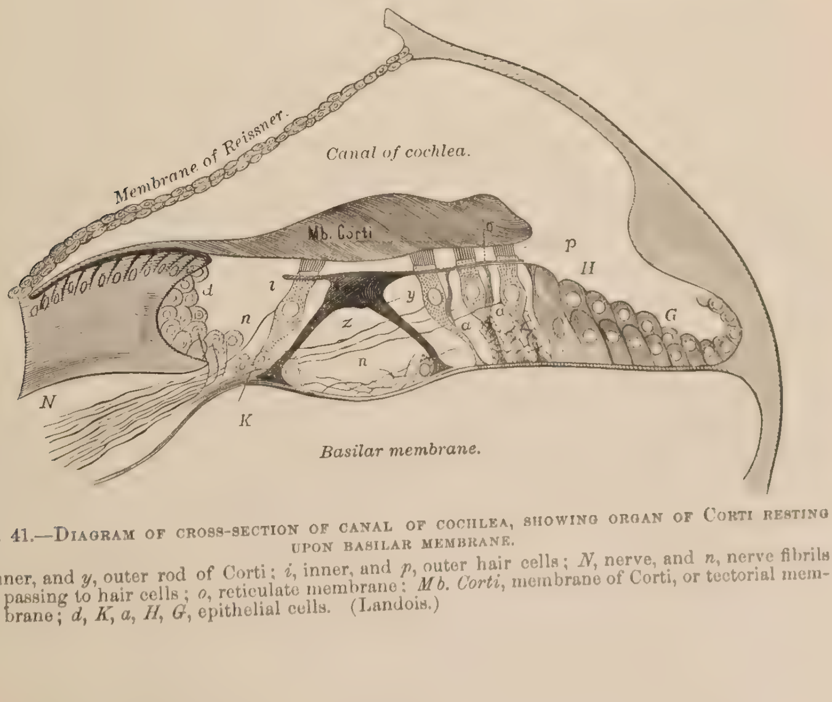

FIG. 41.—DIAGRAM OF CROSS-SECTION OF CANAL OF COCHLEA, SHOWING ORGAN OF CORTI RESTING UPON BASILAR MEMBRANE.

z, inner, and *y*, outer rod of Corti; *i*, inner, and *p*, outer hair cells; *N*, nerve, and *n*, nerve fibrils passing to hair cells; *o*, reticulate membrane; *Mb. Corti*, membrane of Corti, or tectorial membrane; *d*, *K*, *a*, *H*, *G*, epithelial cells. (Landois.)

the particular part of the basilar membrane that is put into vibration. The fibres of which the membrane is composed, about twenty-four thousand in number, become increasingly longer from the base to the apex of the cochlea. It is conceivable that, just as is the case in the piano, the longer fibres vibrate to the lower notes only, the shorter fibres to the higher notes only; and with each note the hair-cells that rest upon that portion of the membrane and their contiguous nerve fibres are stimulated. Quality of sound depends upon the number and prominence of the overtones that accompany the fundamental tone. When a piano-key is struck and a single wire is put into vibration, other wires vibrate in unison and produce overtones. So in the basilar membrane of the ear, when one part vibrates other parts vibrate, and nervous impulses are produced corresponding to the fundamental tone and the overtones of the sound that comes to the ear. Recognition of loudness depends upon the extent of vibration of the basilar membrane. Therefore, according to the theory of the all-importance of the basilar membrane in hearing, a sound after coming to the ear and reaching the membranous labyrinth is analyzed into its constituent vibrations. Nervous impulses corresponding to the various vibrations are produced in the fibres of the auditory nerve, are transmitted to the brain, and give rise to sensations. These various sensations are combined and elaborated into a perception of the sound. It should be said that this theory is not wholly satisfactory.

Recognition of Pitch, Quality, and Loudness.

The semicircular canals and their nervous end-organs, the *cristæ acusticæ*, seem to have nothing whatever to do with hearing. They are sense-organs of bodily equilibrium; they enable the individual to recognise the turning of the head and of the body out of one position into another. They are especially prominent in fishes and in birds—animals that spend much of their time in diving and turning in fluid media, the water and the air respectively. In each ear the planes of the three canals are nearly at right angles to each other, so that they represent the three planes in space. Each canal is hollow and filled with endolymph, and its *crista acustica*, which lies in the enlarged ampulla, seems specially adapted to stimulation by movement of the contained liquid (Fig. 42). The cells about which the nerve-fibres terminate are tipped with long hairs that project into and float in the endolymph. Any curved movement of the head in or approximately in the plane of a canal may readily cause a bending of the hairs and a stimulation of the nerves. If a movement of the head takes place in any other plane, two or more canals may be stimulated at once, and by means of the six canals of the two ears acting in various combinations curved movements in all possible planes in space

Semicircular Canals.

may be appreciated. Roughly speaking, the canals act as spirit levels, and the delicacy of their action is realized when we consider with what accuracy we can detect the slightest turning of the body out of equilibrium.

Saccule and Utricle.

Whether the saccule and the utricle are auditory in function is in great doubt. It was once believed that their nervous terminations appreciate noises as distinct from musical sounds, which stimulate the cochlear organs. But it now seems probable that the cochlea deals with both kinds of sounds. Structurally the *maculæ acusticæ*, the two nervous end-organs upon the walls of the saccule and the utricle, are similar to the cristæ of the semicircular canals; the hairs are shorter, however, and lying upon and among them is a mass of calcareous crystals, the *otoliths.* Experiments upon fishes make it practically certain that these organs appreciate the position of the head, and thus of the body, in space, and hence are organs of equilibrium of the body when at rest. The mode of stimulation is believed to be by the constant pressure of the otoliths upon the hair-cells, and the production thus of a constant nervous impulse that gives the individual an idea of his position; if the body be thrown out of the normal attitude, the pressure of the otoliths is altered, and thus the individual recognises his new position. Experiments upon fishes indicate also that the saccule and the utricle appreciate simple progressive bodily movements in a straight line. It seems not unreasonable to suppose that these parts may have in man the same functions as in the lower animals. If this be so, the semicircular canals, the saccule, and the utricle act together and form a most efficient organ of equilibrium for the body in all possible movements and in all possible positions. It is an interesting but unsolved problem as to how the organ of equilibrium and the organ of hearing became associated with each other in the ear.

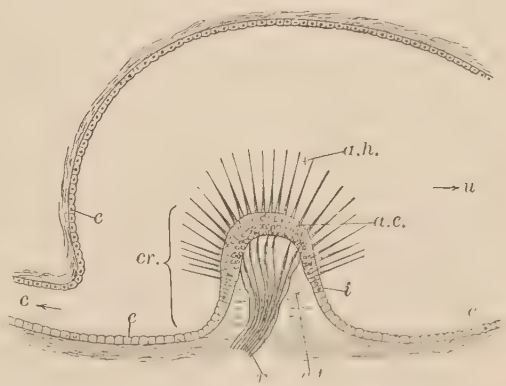

FIG. 42.—DIAGRAM OF LONGITUDINAL SECTION OF AMPULLA OF SEMICIRCULAR CANAL, SHOWING CRISTA ACUSTICA (*cr.*)

c, opening into canal; *n*, opening into utricle; *e*, epithelial lining of ampulla; *n*, branch of auditory nerve supplying crista; *a.e.*, hair cells; *a.h.*, hairs projecting into endolymph; *c.t.*, connective tissue. (Huxley.)

Section III.

SMELL. TASTE.

Smell.

Different animals vary greatly as to the relative importance of their various sensations. The world is made known to man, for example, chiefly through sight, hearing, and touch. The dog's world is largely a world of odours, and in him the sense of smell, comparatively unimportant in man, is very acute. A substance, in order to be smelled, must be either in a gaseous or in a very finely divided condition. The organs of smell comprise the upper portion of the two cavities of the nose; the lower portion serves as a passageway for air in respiration; hence in quiet respiration odours are not usually perceived; they come into consciousness only when they are very strong or when by sniffing the air containing them is forcibly drawn up to the olfactory organs. The organs are very simple, consisting solely of the membrane lining that portion of the nasal cavities (Figs. 43, 44). The membrane is composed of columnar epithelium cells, and contains glands that, together with the cells, secrete the mucus with which the nose is always moistened. Among the cells are scattered long delicate ones that resemble somewhat the rods of the retina, and from which nerve-fibres go directly to the

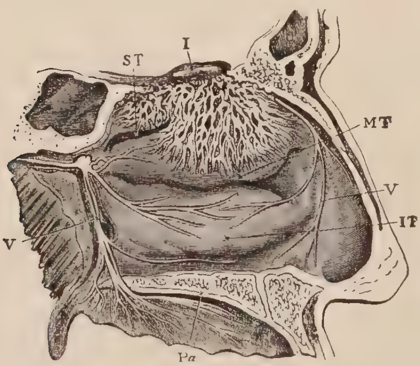

Fig. 43.

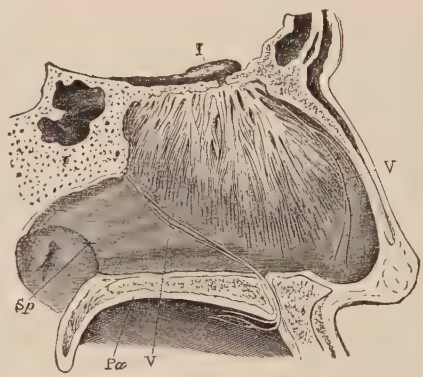

Fig. 44.

Figs. 43 and 44.—Vertical longitudinal sections of the cavity of the nose.
Fig. 43 represents the outer wall of the left nasal cavity; Fig. 44 the inner wall of the right nasal cavity. *ST*, *MT*, *IT*, superior, middle, and inferior turbinate bones; *Pa*, hard palate separating nasal cavity from mouth; *Sp*, septum or partition between the two nasal cavities; *I*, lies within the brain cavity, and points to the olfactory nerve, with its numerous branches; *V*, branches of the trigeminus or fifth nerve. (Huxley.)

brain (Fig. 45). These are the *olfactory* cells, and they are stimulated by the odoriferous substance coming in contact with their exposed ends. The amount of substance needed to cause a sensation of smell is incon-

ceivably small; it is said that ·000000005 of a milligramme of oil of peppermint suffices. No satisfactory classification of odours has yet been made, analogous to that of colours in light and pitch in sound.

The sense of taste, like the sense of smell, is relatively unimportant in man. In many respects it is not unlike the sense of smell. The organs of taste comprise certain portions of the lining membrane of the mouth cavity—viz., the surface of the tongue, the soft palate, and the columns upon either side at the back of the mouth (anterior pillars of the fauces). Situated in the covering of these parts of the tongue, upon some of the papillæ that roughen its surface, are small groups of sensory cells, called *taste-buds* (Fig. 46). The *gustatory* cells composing them are not unlike the olfactory cells in appearance. They are sunk a little below the surface, their exposed ends being reached

Organs of Taste.

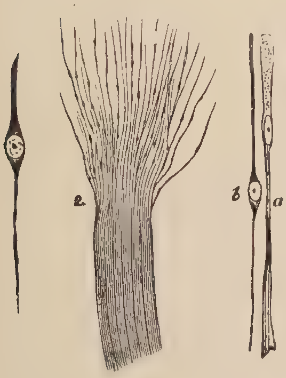

FIG. 45.—NERVE AND END-ORGANS OF SENSE OF SMELL.

1, cells from nasal cavity of frog; *a*, epithelial cell; *b*, olfactory cell; 2, branch of olfactory nerve of frog, terminating in fibrils; 3, olfactory cell of sheep. (Kölliker.)

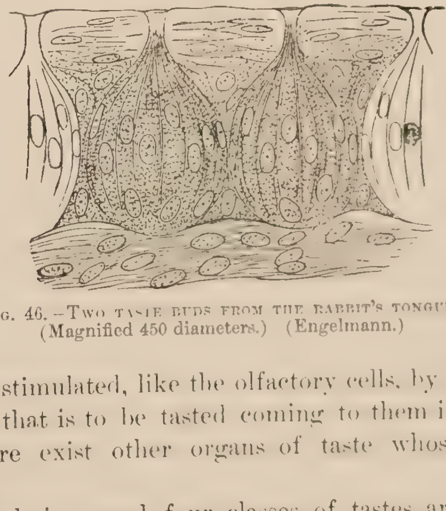

FIG. 46.—TWO TASTE BUDS FROM THE RABBIT'S TONGUE. (Magnified 450 diameters.) (Engelmann.)

through a small pore. They are stimulated, like the olfactory cells, by a minute quantity of the substance that is to be tasted coming to them in solution. It is possible that there exist other organs of taste whose function is as yet undiscovered.

Like colours in light and pitch in sound, four classes of tastes are recognised, viz., sweet, sour, bitter, and salty; and probably all tastes not precisely these are combinations of them. Each of these classes probably has its own end-organs and nerve-fibres. The front part of the tongue tastes sweet and sour substances, the back part bitter substances. Some substances, like a certain compound of saccharin, when placed upon the tip of the tongue taste sweet, upon the back of the tongue bitter, because they are able to stimulate both kinds of end-organs. Taste is assisted greatly by smell, the two senses usually working intimately together. This may readily be proved by the easy experiment of holding the nose, closing the eyes, and then

Classes of Tastes.

endeavouring to distinguish by taste alone between a bit of apple and a bit of onion, or between a particle of banana and a strawberry.

Section IV.

TOUCH. TEMPERATURE. MUSCULAR SENSE. GENERAL SENSIBILITY.

Touch.

By the term "sense of touch" is now meant the sense of pressure. Its organs are localized in the skin, and consist probably of various known forms of *touch corpuscles.* These are minute spherical or ovoid bodies, consisting of cells among which nerve-fibres end, the structure indicating that their natural method of stimulation is by pressure upon the skin overlying them. Recently, physiologists have succeeded in mapping out the surface of the skin into "pressure points," which recognise the touch of bodies applied to the skin, and minute areas between them, which are wholly devoid of the sense of touch. The "pressure points" probably overlie the organs of touch. The forehead and the back of the hand seem to be among the most sensitive parts of the skin, recognising a weight of $\frac{1}{30}$ of a grain, but the tips of the fingers can distinguish more exactly two objects placed near together.

Temperature.

The sense of temperature, also localized in the skin, has only recently been recognised as a sense distinct from that of touch. It comprises, in reality, two senses, that of warmth and that of cold, which are now believed to be so far distinct as to have separate end-organs and separate nerves. Just as with the sense of pressure, so with temperature, it has been found possible to map out the surface of the skin into points that recognise only warmth ("warm spots") and points that recognise only cold ("cold spots"). The warm spots are distinct from the cold spots, and both are distinct from the pressure points. There exist in the skin various sensory organs, besides the touch corpuscles, and it is believed that some of these mediate sensations of temperature, but it is not yet decided as to which are organs of warmth and which organs of cold. The face is the region of the skin most sensitive to temperature.

Muscular Sense.

By muscular sensation we recognise the amount of contraction that a muscle is undergoing; and from such data we form judgments of the size, form, position, and weight of objects. Since muscular contractions occupy so large a field in our daily life, the muscular sense is important. The existence of a muscular sense can be indicated by a simple experiment: If an object be held in the hand and be moved up and down, we have a distinct consciousness of the

tension exerted upon the muscles of the arm ; from this muscular feeling we can form a much more accurate estimate of the weight of the object than from the feeling of pressure of the object upon the skin of the hand ; the feeling of pressure distinct from that of muscular contraction can be studied by laying the hand flat upon the table and placing the object in the palm. What the sensory end-organs are that mediate the muscular sense is not known ; nor is it known whether they are localized in the muscles themselves, in their tendons, or in the joints. There is evidence in favour of each of these three localities.

Touch, Temperature, and Muscular Sense rarely separated.

Although sensations of touch, temperature, and muscular contraction are regarded as distinct and as mediated by three kinds of end-organs, nerves, and brain-centres, as a matter of fact we rarely use one of these senses by itself. They are inextricably bound together in ordinary life. Especially are our judgments of the characteristics of objects that are touched by our hands formed from a mixture of these three kinds of sensations.

Common Sensation.

General sensibility has been referred to as the property by which we recognise, in a vague way, the existence and the condition of the various parts of our bodies. The sensations of pain, fatigue, hunger, thirst, shivering, tickling, nausea, general bodily comfort and discomfort, have all been referred to general sensibility. Since many of these sensations enter largely into our everyday life, it seems strange that we have but little exact anatomical or physiological knowledge regarding them. Future investigation may possibly succeed in lifting some of them out of the ill-defined group of common sensations into new special senses. Pain is now commonly believed to be due to excessive stimulation of nerves of general sensation, and thus to have a nervous mechanism distinct from those of the seven senses.

CHAPTER V.

REPRODUCTION.

Reproduction in General.

The functions so far considered have reference to the daily life, well-being, and preservation of the individual man or woman. But the human being has, in common with other organisms, the instincts of racial continuance, and racial continuance is assured only by the production of new individuals. In the simplest one-celled organisms all individuals are alike, and reproduction takes place by a simple splitting of the individual body into two

bodies. In many-celled organisms sexes exist, individuals are either male or female, and reproduction is more complicated. The essence of sexual reproduction consists in the production by the two sexes of germ-cells (the *ovum*, or egg, by the female, and the *spermatozoön* by the male), the union of these two germ-cells, and the growth therefrom of the new individual. The reproductive organs subserve these three functions. For the structure and relations of the organs the reader is referred to the article on *The Anatomy of the Human Body*.

Egg.

The human egg (Fig. 47) is a soft, delicate, spherical cell, about $\frac{1}{125}$ of an inch in diameter. It consists of protoplasm and a small quantity of food-substance scattered through it. In the egg of the fowl, the egg most familiar to us, the vital part corresponding to the human ovum is in the small whitish spot upon one side of the yolk. To this is added, for the nourishment of the growing chick, the rich food-substance of the yolk and the white, while the shell

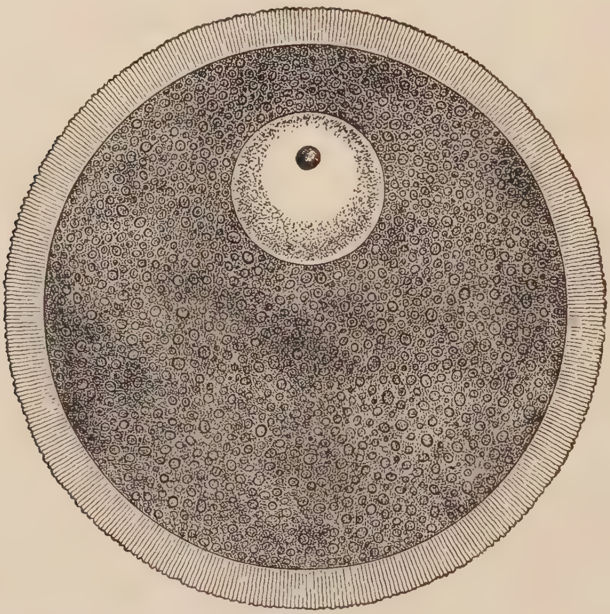

Fig. 47.—A human egg much enlarged.

The greater part of the egg consists of finely granular living protoplasm and coarsely granular lifeless yolk, the two being intimately mingled together. Toward the upper part of the figure lies the spherical *germinal vesicle* or nucleus, within which is the small, denser (dark) *germinal spot* or nucleolus. The egg is surrounded by a thick, transparent egg-membrane, or *zona pellucida*, which is penetrated by fine pore-canals, represented by radiating lines. (Haeckel.)

is a protective covering. The human chick develops within the body of the mother, hence a mass of food within the egg and a shell are unnecessary. Eggs are produced within the ovary of the mother (Fig. 48)

throughout the period of her sexual life—*i. e.*, from puberty, at the age of thirteen to seventeen, until the menopause, at forty to fifty years

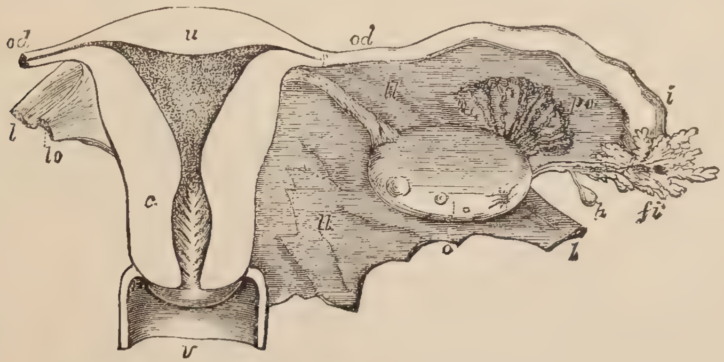

FIG. 48.—FEMALE REPRODUCTIVE ORGANS (TWO THIRDS THE NATURAL SIZE), AS SEEN FROM BEHIND.

u, upper part, and *c*, neck of uterus (in section); *v*, upper part of vagina; *od*, Fallopian tubes (left one cut off) opening into cavity of abdomen at *fi*; *o*, right ovary; *po*, *h*, accessory ovarian structures; *l*, *ll*, *lo*, supporting ligaments.

of age. During this period, at intervals of about twenty-eight days, unless interrupted by pregnancy or disorders, an ovum becomes ripe, breaks through the ovarian wall, and is discharged from the body through the Fallopian tubes, the uterus, and the vagina.

Menstruation.

Accompanying this discharge characteristic phenomena take place in the wall of the uterus and elsewhere, constituting *menstruation*. The lining membrane of the uterus, which has become thick and swollen with blood, rapidly degenerates, breaks away from its attachment, and gradually passes away from the body through the vagina, accompanied by a considerable flow of blood from the torn blood-vessels of the uterine wall, and by mucus. The menstrual flow occupies upon an average about four days. It is preceded by a general increase in physiological activity and excitability, by a rapid pulse and a high temperature, and is accompanied by more or less profound bodily and mental alterations, lassitude, and general vital depression. The significance of this curious monthly cycle, which is an inheritance from our mammalian ancestry, and which finds its counterpart in the "heat" of animals and the actual menstrual flow of the female monkey, is a disputed question. As has been said, menstruation is accompanied by the discharge of an ovum, and there is no reason to doubt that there is an important relation between the two phenomena, and probably between menstruation and pregnancy. According to one prominent theory, the tearing loose of the lining of the uterine wall is for the purpose of providing a fresh surface to which the ovum, if impregnated in its passage outward, can readily attach itself and there develop. An antagonistic

theory supposes the thickened uterine membrane to act as such a bed for the ovum, and the shedding of the membrane to be a sign that the ovum has not attached itself. Menstruation does not usually occur during pregnancy or nursing.

Spermatozoön.

The spermatozoön (Fig. 49) is a curiously modified cell, consisting of a flattened, egg-shaped head, a short, rodlike middle piece, and a long, slender, delicately tapering tail. Its length is from $\frac{1}{400}$ to $\frac{1}{500}$ of an inch. The tail is a locomotor organ solely, and is capable of very active lashing movements, which are sufficiently powerful to propel the whole spermatozoön, when placed in liquid or upon a moist membrane. This is essential to insure the meeting of the two germ-cells. The spermatozoa are produced in the testis along with some liquid; the mixture, together with liquid secreted by other glands connected with the generative passages, constituting a thick, whitish fluid, the *semen*. The semen is produced from puberty until old age, and is stored in the testis, in its duct, and in the seminal vesicles.

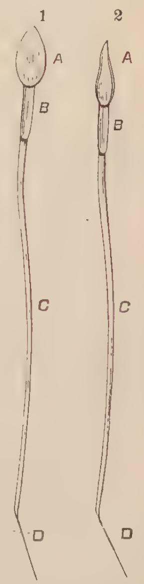

FIG. 49.—HUMAN SPERMATOZOA. (Magnified 600 diameters.) 1, flat view; 2, side view. *A*, head; *B*, middle piece; *C*, tail; *D*, terminal filament. (From Flint, after Landois.)

Fertilization.

During sexual union the seminal fluid is transferred from the body of the male to the vagina of the female, whence the spermatozoa make their way by their own movements through the uterus and along the Fallopian tubes. Here they may live for several days awaiting the discharge of an ovum. If the egg appears, one spermatozoön bores its way into it, the tail being left outside to die. The head of the spermatozoön and the ovum fuse together, the process being called fertilization, and the development of the new being is then ready to begin. Thus it is seen that every individual begins his life as a single minute cell within the body of the mother, which cell consists of material substance derived partly from the body of the father, partly from that of the mother.

Growth.

The phenomena of embryonic growth that follow fertilization are probably the most remarkable of all vital phenomena, and are of surpassing interest. The impregnated ovum divides into two cells, each of the two into two, making four cells, the four into eight, the eight into sixteen, and so on (Fig. 50), this process being called segmentation. At the same time the segmenting egg passes along the Fallopian tube and enters the *uterus*, or *womb*, which for the subsequent nine months is to be the home of the future human being. The egg attaches itself firmly to the uterine wall and becomes embedded in and

covered over by its lining membrane, which in the meantime has become congested with blood, and has grown rapidly, as before menstrua-

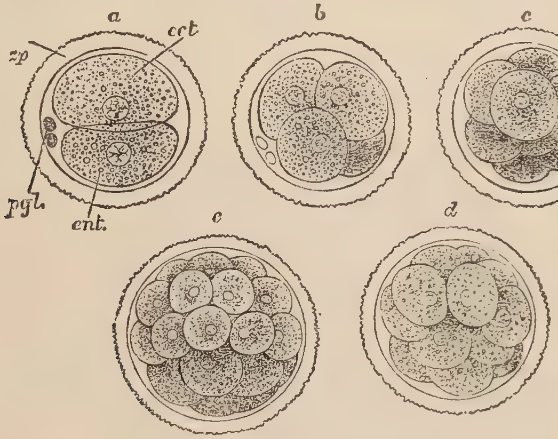

FIG. 50.—SEGMENTATION OF THE EGG OF THE RABBIT.

a, two-celled stage; *b*, four-celled stage; *c*, eight-celled stage; *d*, *e*, further stages; *ect*, cell destined to give rise to *ectoderm*, or outer layer of embryonic cells; *ent*, cell destined to give rise to *endoderm*, or inner cells; *zp*, zona pellucida; *pgl*, polar globules, or cast-off bits of nucleus. (Much magnified.)

tion. The number of cells in the young and delicate embryo increases; the cells become differentiated in size, shape, and function, and form the tissues and the organs. The embryonic heart begins to beat, by degrees the human form is evolved, and the child is gradually prepared for its entrance into the world.

Into the details of embryonic growth we can not here go. One point we may refer to—that is, the anatomical and physiological connection that exists between the infant and the mother.

Placenta.

The embryo, surrounded by fluid and by membranes, develops within a cavity in the wall of the womb, and by its continued growth and increase in size the original cavity of the womb becomes practically obliterated (Fig. 51). The embryo, however, is free from actual attachment to the maternal tissues except at one point—the navel of the child is connected by the umbilical cord (Fig. 51) to a considerable area of the uterine wall, the attachment being the *placenta*. The placenta is the embryonic organ of nutrition—food reception, respiration, and excretion. The embryo, inclosed as it is, is incapable of using its alimentary canal, lungs, and organs of excretion, and hence all its income and outgo must be carried on between its own blood and that of its mother. The blood and the blood-vessels of the two are quite distinct from each other; the child has its own intrinsic blood system. But in addition to this the large umbilical artery passes from its body along the umbilical cord, there to end in the placenta in thin-walled

tufts that penetrate into large spaces filled with the mother's blood. The embryonic and the maternal blood are separated by a thin membrane only, that allows ready diffusion of food, oxygen, carbonic acid, and wastes. The embryonic blood is purified and refreshed at the ex-

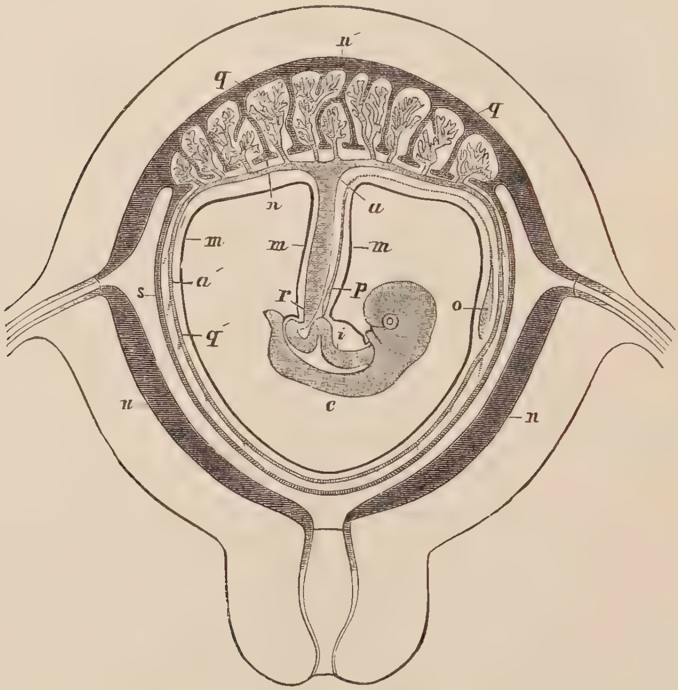

FIG. 51.—EMBRYO WITHIN THE UTERUS. (Diagrammatic.)

c, embryo; *i*, alimentary canal of embryo; *r*, *p*, *m*, *m*, various structures composing the umbilical cord; *q*, *n'*, *q*, *a*, placenta; *m*, *a'*, *q'*, *s*, membranes surrounding embryo; *n*, *n*, lining membrane of uterus: at each side extends off a Fallopian tube, and below is the neck of the uterus. (Liégeois.)

pense of the mother, and is returned by the umbilical vein to the body of the child.

Birth.

The usual duration of pregnancy is about forty weeks. Toward its close the presence of rhythmically repeated pains in the uterus heralds the birth of the child. These pains of labour are accompaniments of wavelike contractions that pass over the muscular uterine walls. With each succeeding contraction the walls press closer and closer upon the fœtus, the opening of the womb and the vagina relax, and the child is slowly and painfully forced upon the world. The first breath is drawn into the lungs, and the infant announces its arrival by cries of distress. The umbilical cord is tied and cut; a few minutes after birth the placenta is expelled; and after this the wounded uterus gradually heals.

Usually for some time after birth the child continues to depend upon the mother for its sustenance. During pregnancy the mammary glands of the mother, which form the breasts, increase in size and in functional power, and at the time of birth they are capable of secreting the milk that the child requires. Human milk is essentially not unlike the milk of other female animals. It contains, however, somewhat more sugar, and is more watery than cow's milk.

Milk.

We can not bring this chapter to a close more fittingly than by a brief review of the physiological life of the individual and a reference to some of its more special features. A lifetime may be divided roughly into three periods: those of youth, of middle life, and of old age. Youth is the period of growth, middle life that of maturity, and old age that of decline. A sharp distinction between these three is, however, impossible; the coming of age of the individual at twenty-one years is a convenient legal fact, but not a principle of nature. Growth in height may continue until about twenty-five years of age, and after fifty years a diminution of stature may follow. Weight may continue to increase until forty years, and after sixty years it may decrease. From about ten to fifteen years of age girls grow more rapidly than boys, the year of most active growth in girls being, in Europe and the United States, the thirteenth. After the fifteenth year boys surpass girls in rate of growth, their most active year being the sixteenth. Girls reach puberty before boys, and attain their complete growth at an age three or four years younger than boys. The metabolism during the period of youth is of necessity largely constructive, during middle life the constructive and destructive phases balance each other, and in old age destructive metabolism, with possible fatty or calcareous degeneration of tissues, becomes more prominent. In comparison with the young of most other animals, the human infant comes into the world very immature and helpless. Hence the period of youth is largely devoted to a perfecting of the various functions, and especially to the forming of associations and the laying out of paths of greater and less resistance within the central nervous system—in a word, to the formation of habits. Many functions vary in their activity periodically. As examples of such variations may be mentioned the common increase of weight in winter and decrease in summer, the monthly menstrual flow, a regular daily variation in temperature, such that the highest temperature occurs between 9 A. M. and 6 P. M., the lowest between 11 P. M. and 3 A. M., and a similar daily variation in the pulse rate and in the rate and depth of respiration.

Lifetime of Individual.

Of all the daily rhythms, the alternation of sleep and waking is the most striking. Sleep is, in brief, a profound depression of the activities

of the central nervous system. The muscular reflexes, the activities of the sense-organs, respiration, secretion by the glands, and general metabolism are all depressed, perhaps as the result of the central depression; but the absence of consciousness—that is, the depression of the activities of the psychic cells—is the most pronounced feature of sleep. That the psychic activity is not always wholly eliminated is evidenced by the occurrence of dreams, but the fragmentary and grotesque character of dreams indicates that but a few brain-cells are engaged in their production. The reason for this periodic depression of brain activity has been long sought, but with little success. Perhaps the accumulation within the body of the waste products of protoplasmic activity causes a temporary paralysis of the brain-cells, lasting until the wastes are removed. However this may be, the amount of blood in the brain is probably considerably less during the sleeping than during the waking hours, and this may of itself cause cerebral depression.

Sleep.

Sooner or later, even if disease and accident are safely overcome, the vital machine is doomed to wear out, and death follows. Physiologists recognise two kinds of death: death of the individual and death of the tissues. The individual dies when the heart ceases to beat and to supply the whole body with food and oxygen. But the individual tissues vary very greatly in the time of their death. The nervous tissues die almost immediately, but the muscles are capable of contraction upon artificial stimulation for a considerable time after the thinking man has forever ceased his activities. Probably not for several hours do all the chemical changes take place within the protoplasm that are the evidence of the passing away of that mysterious, unexplained condition that we are wont to call life.

Death.

CHAPTER VI.

HEREDITY.

In the vast world of life nothing seems more marvellous than the fact of inheritance. Like produces like; a child resembles its parents.

This fact is easily comprehensible in the one-celled organisms, where the parent cell, after a period of activity, puts an end to its individuality by an equal division of its whole body into two similar offspring, and nothing is lost. But in the higher and larger animals, composed of countless millions of cells that are specialized in a great variety of ways, the vital material contributed by the parents consists solely of the two microscopic germ cells,

Inheritance a Biological Fact.

and from this infinitesimal beginning there comes an organism that resembles, often in minute and unimportant details, the parents, the grandparents, and even remote ancestors, and that does not resemble other races. Here, if anywhere in our search after natural causes of things, it seems necessary to bring into causal relation the supernatural, and to hide our helplessness in an assumption of some mysterious guiding force that is distinct from vital matter and that we know not of. Truly, we know little of natural law, but the restless scientific spirit of man is ill content with a supernatural explanation of heredity. Inheritance is a biological fact, and must be explained in accordance with biological laws.

Facts of Inheritance.

Before proceeding, however, to the explanation, let us review in some detail the facts that must be explained. We have said that like produces like. This statement must be accepted with certain modifications. Obviously, no two individuals are like each other in all points; twins, indeed, may be "as like as two peas," and yet one is not the mirrored image of the other. As a general law, a child resembles its parents more closely than it resembles any other individual. Between its parents, the resemblance is in some cases more strongly in favour of the father, in other cases in favour of the mother; in still others, both paternal and maternal characteristics seem to be present in approximately equal proportions; rarely is the child "the exact image" of either parent. At times, however, the offspring seems to possess almost or quite none of the parental qualities, but to show likeness to grandparents or great-grandparents, either as regards general or as regards particular features or qualities. The reappearance of an ancestral quality thus, after having lapsed in one or more generations, is called *atavism* or *reversion*, and the subject forms one of the interesting chapters in the story of heredity. Lastly, in rare cases a child seems to be a veritable "black sheep," and to possess no qualities whatever that ally it to its progenitors. In speaking of inherited resemblances, we do not mean to confine ourselves to mere anatomical matters; likeness of feature, of form, of size, of structure, is most obvious, and is the kind of resemblance most commonly sought for. But likeness in things physiological and things psychological, in the mode of working of the body and of the mind, in things moral, in peculiarities of temperament, is as common, if not so readily perceived. In fact it is difficult, if not quite impossible, to draw the line between features and qualities of the parent that are heritable and those that are not so.

The question of the inheritance of disease has been much debated. It seems to be a fact that the germs of certain infectious diseases, such as syphilis, may be conveyed to the child's organism within the parent's germ cells, or even directly from the mother's body to the growing embryo. It seems also probable that predisposition to certain diseases, in the form

of constitutional weakness and diminished power of resistance to the disease germs, is heritable. Probably the apparent transmission of consumption is thus to be explained. Inherited predisposition and the fact that the child is usually brought up in the home of its consumptive parents, with every opportunity of acquiring the very germ that it can not successfully resist, are probably responsible for many attacks of this fatal malady. Predisposition to nervous diseases, to insanity, to suicide, and to crime, are certainly transmissible.

Inheritance of Diseases.

A second much-debated question is that as to whether new characteristics acquired by a parent may be transmitted to his child. To the mind of the layman, and at first thought the question seems superfluous, for apparently there are innumerable instances of such transmission about us—the affirmative side of the question goes without saying. But when we examine the evidence carefully we are surprised at its inconclusiveness. In one case the peculiarity is found, after all, to be not one acquired by the parent, but one possessed also by other ancestors—to be inherent in the race; in another case, what is inherited may easily be a tendency, a strength or weakness of mind or character, that with a suitable environment may show in the child in the same striking manner as in the parent, and yet that is in no sense an inheritance of anything acquired by the parent—such, for example, as a taste for strong drink; in another case, the parent's peculiarity may prove, upon examination, to have been obtained subsequent to the birth of the child! And thus, one by one, innumerable cases of seeming inheritance of acquired characters have been disproved. Experimental investigation has proved equally inconclusive. For centuries the Chinese have compressed and distorted the feet of their girls; yet the feet of Chinese girls born at the present time are apparently not different from those of a generation a thousand years ago. Numerous researches made in recent years upon the dehorning of cattle and the removal of the tails of mice for a long series of generations have resulted in no reduction of the horns in the one case or of the tails in the other. Hence, though there are still many seeming arguments in favour of use and disuse as important factors in evolution and in heredity, there are many persons that exclude these utterly from their creed, and so the matter of the inheritance of acquired characters must be left for the present undecided.

Inheritance of Acquired Characters.

In view of the above facts it seems idle, and it is certainly misleading, to talk of the equality of men, for Nature has established classes that are much more firmly ordained than are those of society. The environment of the child and the man has much to do with what the individual accomplishes in the world, but the environment works upon material that already is moulded in great part by past

Heredity powerful.

generations. The inherited qualities of one person place him at once well in advance in the struggle for existence; those of another too often prove a serious handicap. Heredity is a powerful factor in human progress. It is to be hoped that a greater knowledge of its facts and principles will gradually modify existing educational systems for the young and penal systems for criminals.

Germ-plasm.

How, now, may the above facts of inheritance be explained? Leaving aside all metaphysical and theological theories as unbiological and inadequate, we must start with the belief, incredible as it may seem, that the bits of protoplasm that constitute the ovum and the spermatozoön contain within themselves in some form the qualities of the mother and the father respectively, and to some extent of more distant progenitors. Probably we can go even further than this, for there is much evidence that the real carrier of the hereditary qualities, the *germ-plasm*, is confined to the nuclei alone of the two germ cells. We have already seen that the tail of the spermatozoön is a locomotor organ, and dies after conveying the head to the ovum; the head consists chiefly of nucleus, and it alone enters the egg. Likewise, within the ovum the mass of egg substance seems to subserve nutritive and other purposes, while the nucleus alone is probably essentially hereditary. The fusion of the spermatozoön and the ovum is a fusion of their nuclei, and the segmentation of the egg is primarily a nuclear phenomenon.

Darwin's Theory of Pangenesis.

But how is it possible for the minute germ-plasm to obtain and to hold the parental qualities? This problem has been the subject of much speculation, especially since the writings of Darwin set men to thinking of the origin of species and the mechanism of descent. In his book entitled *The Variation of Animals and Plants under Domestication*, published in 1868, Darwin gave to the world his own hypothesis of inheritance in a chapter entitled *Provisional Hypothesis of Pangenesis.* In brief, this theory supposes that all parts of the body are giving off at all times excessively minute particles, the germs of the various cells, or *gemmules*, as Darwin called them; these pass into the circulating blood, are carried to the reproductive organs, and become a part of the germ cells. Hence every germ cell is a mass of germs of the body cells of the parent, together with some gemmules of more remote ancestors, and hence the fertilized ovum contains the potentialities of the image of either parent and of some more ancient ancestral characteristics. Darwin's gemmules are somewhat of the nature of Herbert Spencer's hypothetical "physiological units," which, before Darwin wrote, were used by Spencer to explain heredity. Darwin's hypothesis allows the transmission of characteristics that are acquired by the parent; for an alteration of any part by use, disuse, loss, or injury might cause altered gemmules to go to the germ cells, and the

child might then show in the corresponding part of his body the effects of use, disuse, loss, or injury in the parent. Darwin's theory is purely speculative. Neither he nor later biologists have known, as an observed fact, any such giving off of germinal units as he assumes. The theory has not been generally accepted; for, apart from the inconceivability of the presence of so vast a number of germs within a single minute cell, many facts render it improbable. But it has served a useful purpose, as doubtless Darwin intended it should serve, in stimulating thought and investigation.

Weismann's Theory.

Since the appearance of Darwin's provisional hypothesis a large literature upon heredity has appeared, and several theories have been proposed. Some of these follow Darwin and attempt to supply lacks in his explanation; others are far removed from his speculations. We have here space to mention but one of these, which has attracted wider attention than any other, and which has been the subject of widespread and earnest discussion. This is the theory of Prof. Weismann, of the German University of Freiburg, who since 1881 has published several volumes of essays upon this and kindred subjects. Weismann is a careful and conscientious thinker. His theory has been developed gradually, and, as the significance of his main conceptions has broadened with continued thought and investigation, his later writings contain modifications of his earlier views.

The Continuity of Germ-plasm.

The nucleus of Weismann's theory is expressed by his own phrase, "*the continuity of the germ-plasm.*" This phrase means that, according to his idea, the germinal or hereditary substance that is present in the ovum or the spermatozoön of any individual, whether man, lower animal, or plant, has come directly from the germinal substance of the parent of the individual; that the germinal substance of the parent likewise has come directly from that of the parent's parent; that the germinal substance of any individual may be traced through parent, grandparent, great-grandparent, and so backward to the remotest ancestors; that, in a word, germinal substance, arising far back in the lowly and primitive predecessors of existing organisms, has been and is continuous in each line of descent throughout all generations. Hence, germinal substance does not arise *de novo;* it does not originate within a body by the concourse of multitudinous minute "gemmules" that are given off from all parts of the body, but it is derived solely from pre-existing germinal substance; in this sense all individuals are powerfully and equally "blue-blooded." Every individual, therefore, begins life as a minute mass of germ-plasm, that consists partly of male germ-plasm and partly of female germ-plasm, and that in the case of the human being is destined to grow and develop into the child within the mother's womb. As growth and development go on, much of

the germ-plasm differentiates, and produces the various cells, tissues, and organs of the child's body. A small portion, however, remains undifferentiated, and takes up its residence in the essential reproductive organ of the child—in the ovary, if the child be a girl, in the testis if a boy; and this undifferentiated residue which, as has been seen, has come directly from the parents, is the germ of the future progeny of the child.

Germ-plasm and Somatoplasm.

Hence, according to Weismann's theory, the body of every individual consists of two kinds of protoplasm, viz., *germ-plasm*, or hereditary substance, which in its undifferentiated form resides within the essential reproductive organ, and is the derivative of past and the progenitor of future races; and *body-plasm*, or *somatoplasm*, which is the protoplasm of the rest of the body, the muscles, the glands, the heart, and the brain. The latter serves the daily needs of the individual and dies when the individual dies. The former subserves reproduction alone; if the individual reproduces its kind, some of the germ-plasm is passed on to the descendant; if the individual does not reproduce, the germ-plasm dies with him, and that particular line of descent is forever ended.

Relation of Germ-plasm and Somatoplasm.

Thus far Weismann's theory seems readily comprehensible and reasonable. But let us carry it, as its author does, a little farther. What relation within an individual body do these two kinds of protoplasm—the germ-plasm and the somatoplasm—bear to each other? Do changes in the one necessarily affect the other? Weismann believes that the two are quite independent of and distinct from each other. They are nourished by the same nutrient blood and lymph, it is true, and any general alteration of the nutrient fluids alters the nutrition of the two alike; but this is of comparative unimportance. The important consideration is that any alteration of a particular part of the body-protoplasm does not affect the germ-plasm; in the origin of the latter from the parent's germ-plasm instead of from the individual's own somatoplasm, and in the absence of gemmules passing constantly from somatoplasm to germ-plasm, the latter can not reflect the condition of the former. Hence, the loss of a limb by accident, the gain of strength in particular muscles by athletic exercise, the acquisition of an art, like piano-playing, which consists of delicate and intricate muscular and nervous adjustments, the long-continued mental development of the man or the woman which carries with it molecular adjustments of brain substance, the practice of a trade or profession which develops abnormally certain organs, or tissues, or cells, and allows other organs, tissues, or cells to degenerate—all these affect the germ-plasm in no wise, and can not be transmitted to the descendants of the individual. Characteristics acquired by the parent are, therefore, not inherited by the child. The *non-inheritance of acquired characters* is

the second fundamental postulate of Weismann's theory, and is to be placed beside that of the continuity of germ-plasm.

Variation.

Why, then, are not all children alike mentally, morally, and physically? From a common origin in the early history of organic beings, with a descent through numberless generations by a continuity of germ-plasm that leads a charmed life of a certain degree of independence of environmental changes, how is variation possible, and how may the differences of individuals and of races be accounted for? In the first place, germ-plasm is not wholly independent of environmental changes. It is capable of, and is constantly undergoing, alteration as the result of general nutritional alterations taking place in the body in which it is housed. The germ-plasm of one line of descent must therefore necessarily differ somewhat from that of another line of descent, since the environment of the one differs from that of the other. In the second place—and here we have the chief source of variation—the individual is the result of a fusion of two varieties of germ-plasm, that of the father and that of the mother, each with a history and capabilities differing from those of the other. Therefore the resultant organism, while possessing ancestral qualities, must possess them in a combination that has never before existed; it must differ from any organism that has preceded it; and hence it follows that no two individuals, or two species, or two races can be alike.

These, then, are the elements of Weismann's theory: continuity of germ-plasm and non-inheritance of acquired characters tending to preserve the uniformity of the race; slight germinal changes and sexual reproduction tending to destroy that uniformity.* During the past ten years and more the theory in its manifold details has been fought over with great vigour by its friends and its foes. The contest has been especially warm over the question of the inheritance of acquired characters.

We have thus touched very incompletely upon some of the principles and problems and attempted explanations of the mystery of inheritance. To the scientist a mystery is always inviting, and to the modern biologist that of heredity is especially so. What is needed most is careful, truthful observation and recording of the facts that are all about us, and well-directed, painstaking and unprejudiced physiological experimentation as to hereditary possibilities. Darwin, Galton, Weismann, and others have done much of the former service; the latter belongs largely to the science of the future.

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* *Essays upon Heredity and Kindred Biological Problems.* By August Weismann. Authorized translation. Vol. I, 1889; Vol. II, 1892. Oxford, The Clarendon Press.

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III.

OUTLINES OF PSYCHOLOGY, OR A STUDY OF THE HUMAN MIND.

By JOSIAH ROYCE, Ph. D.

BIBLIOGRAPHY.

Of standard general treatises on psychology, the reader may be referred to the following, which are selected from the great number of modern books:

Bain. *The Senses and the Intellect*, and *The Emotions and the Will*, 2 vols.

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Wundt. *Lectures on Psychology.*

James, William. *Psychology.* Longer course in two volumes, shorter course in one volume.

Baldwin, James Mark. *Handbook of Psychology*, 2 vols.

Sully, James. *The Human Mind*, 2 vols.

Sully, James. *Outlines of Psychology*, 1 vol.

Ladd. *Physiological Psychology*, 1 vol.

Ladd. *Psychology, Descriptive and Explanatory*, 1 vol.

On the methods to be pursued by the psychologist there is a German treatise, written from the modern point of view, by Prof. Hugo Münsterberg, entitled *Aufgaben und Methoden der Experimentellen Psychologie.* The principal modern German treatise on psychology is the *Physiologische Psychologie* of Wundt, in two volumes.

PSYCHOLOGY.

§ 1. The purpose of the following sketch is twofold. For the first, the reader is to be introduced, in a very general way, to the study of the human mind. For the rest, this account will give also incidental suggestions regarding the practical applications of such study to the problems of the estimate and the guidance of minds in health and in disease. The necessarily limited space will forbid any but the most summary statements.

I. INTRODUCTORY DEFINITIONS AND EXPLANATIONS.

§ 2. Psychology, in a general way, has the same sort of relation to the functions of the human mind that physiology has to the functions of the human body. Psychology is, namely, the doctrine which attempts to describe and, as far as possible, to explain our mental life. And by our mental life, as opposed to our physical life, we mean a certain collection of states and of processes with which, from moment to moment, each one of us is, in his own case, very directly or immediately acquainted, while, on the other hand, it is impossible that any one else besides the original observer, whose mental life this is, should ever get this immediate sort of acquaintance with just this collection of states and processes. Herein, then, lies the essential characteristic of our mental life. Others may learn, from observing our acts and our words, a great deal *about* this our own mental life; but each one of us is the only being capable of becoming directly aware of his own mental states. On the other hand, however, our physical life, in its external manifestations, may be observed by any one who gets the opportunity. And thus the fact that the mental life of each one of us can be directly present, as a series of experienced facts, to one person only, may well be used as a means of defining the difference between our physical and our mental life. Thus physical facts are usually conceived as "public property," patent to all properly equipped observers. All such observers, according to our customary view, see the *same* physical facts. But psychical facts are essentially "private property," existent for one alone. This constitutes the very conception of the difference between "inner" psychical or mental and physical or "outer" facts—a conception behind which, in the following discussion, we shall not seek to go.

Mental Life.

Physical Life.

§ 3. It is this fundamental difference that leads us often to speak of the mental as the "internal life" or the "inner world," and to oppose it both to our own physical life and to the "external physical world." This way of expressing the distinction between mental facts and all others is fairly good, but must be carefully guarded against misinterpretation. The physiological processes of our bodies are physical, but are indeed also often viewed as "internal," since they go on within our bodies, and are in general mainly hidden from direct external observation. But our mental life is "internal" in quite a different sense. Digestion, circulation, and the changes of our tissues are processes which are actually altogether hidden from many forms of outer observation, and which, at best, can only be observed very partially, and for the most part very indirectly, by observers who view us from without. But, on the other hand, these processes, in case of each one of us, are also very ill known to us ourselves, and are in large part not even indirectly represented by any of our own

conscious mental states. So that, when we speak of our physiological processes as internal, the word "internal," although it here generally implies "hidden, in whole or in part, from actual outer observation," does *not* imply "directly felt by us ourselves." But when we speak of a pain as an "inner" mental fact, we mean that while nobody but the sufferer can possibly get any direct acquaintance with its presence, the sufferer himself can do so, and is aware of the pain. Furthermore, the fact that other observers cannot directly watch our inner physiological processes, is itself something relatively accidental, dependent upon the limitations of the sense organs, or upon the defective instrumental devices of those who watch us. But the fact that our mental states are incapable of observation by anybody but ourselves seems to be not an accidental, but an essential character of these mental states. Were physiologists better endowed with sense-organs and with instruments of exact observation, we can, if we choose, conceive them as, by some now unknown device, coming to watch the very molecules of our brains; but we cannot conceive them, in any possible case, as observing from without our pains or our thoughts in the sense in which physical facts are observable. Were my body as transparent as crystal, or could all my internal physical functions be viewed and studied as easily as one now observes a few small particles eddying in a glass of nearly clear water, my mental states could not even then be seen floating in my brain. No microscope could conceivably reveal them. To me alone would these states be known. And I should not see them from without; I should simply *feel* them, or *be aware* of them. And what it is to feel, or to be aware, I alone can tell myself.

An Essential Character of Mental States.

§ 4. Mental life has thus been defined by pointing out its contrast with all that is physical. Now, psychology is to undertake the study of mental life for the sake of trying to describe and, in a measure, to explain its facts. But this undertaking may, for the first, appear to be quite hopeless. How can one describe, with any sort of accuracy, where the facts to be described are in any case open to the inspection of one observer only? Successful description, made with any scientific purpose, seems to involve the possibility of comparing together the various attempts at description made by different observers in view of the same facts. When astronomers observe celestial objects, they compare the results of the various observations of different astronomers. In the multitude of trained observers, occupying, upon occasion, widely different positions on the earth's surface, but all looking at the same heavenly bodies, the possibility of the growth of astronomical science seems to depend. How, then, shall psychology progress if, in our various mental lives, no two observers can ever take note of precisely the same facts? Is it not as if there were as many real moons

The Function of Psychology.

as there are astronomers observing the heavens, and a different real moon for each astronomer, which nobody but himself could ever see? In such a case one may ask, What would become of astronomy?

Physical Expression.

§ 5. Without in the least going into the extended and interesting philosophical problems suggested by these questions, it is enough here to point out at once that, while no two persons among us can ever observe the same series of mental facts and processes, psychological study is nevertheless made possible by the fact (a fact of the most fundamental importance) that we all of us not only have our mental states, but also appear to *give these mental states a physical expression* in certain bodily acts—viz., in what may be called our expressive functions. The mental states themselves each one of us observes for himself alone. Their physical expression is something that, like any other physical fact, is patent to all observers. Now, anyone of us can often observe for himself what sort of physical expression some given sort of mental states gets in his own case. Thus one can sometimes observe how, by cries or by groans, he himself gives expression to his own pain; or how, by appropriate bodily attitudes, he expresses the mental states of attentive interest which we call "looking," "listening," "watching," and the like; or, finally, how he adapts the familiar words of his mother tongue to the expression of multitudinous inner moods, and other personal experiences, for many of which, in fact, we have no definite and conscious bodily expression at our voluntary disposal *except* such words as chance to occur to us as appropriate at the moment when these states are passing. Cries, groans, sighs, tears, gestures, attitudes, words, and other far less easily observable expressions—some voluntary, some involuntary—are thus found to accompany our mental processes. But all these expressive movements are themselves facts in the physical world, and are, as such, matters both for common observation and for exact scientific scrutiny. Most of these expressive acts show marked similarity, either in several, in many, or in all men. And meanwhile, what states in each one of us they express, the individual observer experiences for himself. In attempting to describe our mental experiences to one another we therefore constantly make use of the names of familiar expressive functions, such as laughter, weeping, and the like. Some of our expressive acts, like the ones just named, viewed apart from their names, are of instinctive origin and are only partially under the influence of conventions. Other expressive acts, like the use of the words of our mother tongue to embody or to describe our mental states, are of purely conventional origin, and have only become moulded by slow degrees to a certain sort of uniformity as regards their relation to similar mental states in many people. Whether one person means by the word "love" a state very closely similar to the state that another person means

by the same word may be, and often is, a very difficult question to decide. Yet the use of the words of our common mother tongue to express our mental states, guided as this use has been since childhood by the effort to conform our expressions to the comprehension of our fellows, is often brought to a point which enables us to be decidedly sure that the states which many people agree in describing in given words are themselves in pretty close agreement. With some caution, the same may be regarded as true, within limits, as to the states described in various languages by parallel words and phrases. While we are then unable to make our mental states objects of common observation, in the sense in which the astronomers are said to observe the same star, we nevertheless can observe in common our natural and conventional, our simple and complex, our voluntary and involuntary, our more subtle and our less subtle motor expressions of our mental states, whether in our outward deeds or in the permanent products of these deeds (as in works of skilful art), or in our words, or in our momentary gestures, or, finally, in our established habits of behaviour. The inner meaning of such expressions each of us can, by more or less attentive scrutiny, discover for himself. Their agreement in many persons enables mental facts, private though they be, to be indirectly submitted to a comparative study in many people, and to some sort of generalisation, classification, and even explanation.

Physical Conditions.

§ 6. While this outward physical expression, which our mental life gets, makes psychology, as a comparative and more or less scientific study of mind, possible, our study itself is very greatly aided by a further consideration—viz., that we not only express our minds through our movements, but seem to ourselves to be *dependent*, for at least very much of our mental life, *upon more or less definable physical conditions*, which we recognise, even apart from any special study, as matters well known in daily life, and as matters which we can study in common. Thus the private mental condition is noticed by its one observer to vary with the presence or absence of physical facts that he and his fellows can observe together. That one cannot see in the dark, that one feels cold at a time when the thermometer reveals the physical fact of a low temperature, that violent physical exercise makes one weary—these are facts which have, at the very same time, their psychical aspect manifest to one observer, and their physical aspect manifest to all observers. A more scientific study, moreover, shows us that not merely some, but all of our mental states vary with physical conditions of one sort or another. Now, this sort of union of the public and the private, of the generally accessible and of the purely individual, gives us many means for indirectly comparing and classifying mental facts and for studying their conditions in various people.

§ 7. But both the expressive movements and the physical conditions thus far mentioned prove, upon closer examination, to have a character as physical processes that makes them still further the topics of a scientific scrutiny; for we possess, as a most important part of our physical structure, *our nervous systems.* And it may be shown that the expressive physical functions (acts, gestures, words, habits, etc.) in which our mental life gets its outward representation and embodiment are all of them, as physical events, *determined by physiological processes that occur in our nervous systems.* In other words, the functions of the nervous system, while they include many other processes as well, still also include, as a portion of themselves, precisely those functions by which, from moment to moment, our mental states get expressed. Thus the scientific study of our expressive functions becomes linked to the general study of nervous physiology. On the other hand, however, those numerous physical conditions, both without and within our bodies, which have been mentioned as appearing to determine in some way our mental states, prove to be conditions that are effective *in so far as they at the same time physically influence our nervous systems.* Thus in two ways the scientific study of mental life may get aid from the study of the nervous system.

The Nervous System.

§ 8. Now, the physical functions of the nervous system are capable of a very extended comparative and experimental investigation. Those of the nervous functions which are not closely related (as apparent conditions or as expressions) to our mental processes appear, in the light of such study, to differ from those nervous functions which are so related, chiefly in respect of the relative simplicity of the nervous functions which are not thus closely related to the mind, when compared with the relative complexity of those nervous functions which are more intimately related to mental processes. But no one easily definable dividing line appears between the two, except the familiar fact that the nervous functions most closely related to our mental life are localised, so far as concerns their central stations, in the cortex or grey matter at the external surface of the brain, while the nervous functions that have no discoverable mental accompaniment are, for the most part, directed from centres placed below the level of this brain cortex. Otherwise, as we shall see from time to time hereafter, it is hard to prove any essential difference in kind between the physical functions whose nervous conditions are centred in the cortex and those which are centred lower down. The higher functions are, indeed, often vastly the more complex. They change much more during life, and under the influence of our experience, than do our lower nervous functions. They show more signs of what is often called "spontaneity"—that is, of a certain relative (although never complete) independence of the present external physical

Nervous Centres.

surroundings in which our body chances to be placed. But these, although large differences, are differences of degree. Physically speaking, and despite vast differences in detail, the same general or fundamental types, both of structure and of function, are observable, both high up and low down in the nervous centres.

§ 9. Yet one must insist that the study of neurological facts has, although very great, still only relative value for the psychologist. For one thing, what the psychologist wants to understand is mental life, and to this end he uses all his other facts only as means; and for the rest, *any physical expression of mental life* which we can learn to interpret becomes as genuinely interesting to the psychologist as does a brain function. A pyramid or a flint hatchet, a poem or a dance, a game or a war, a cry or a nest, the nursery play of a child or the behaviour of an insane person, may be a physical expression of mental life such as the appreciative psychologist can both observe and more or less fully comprehend. The study of such facts, and of their physical causes and results, throws light both upon what goes on in minds and upon the place which minds occupy in the natural world. To be a student of psychology thus involves three essential things: (1) To observe carefully the signs which express mental life, and to explain these expressions as far as possible; (2) to examine those physical processes which in any case appear to condition mental life; and (3), with constant reference to the foregoing classes of facts, to analyse by means of a close self-examination, or "introspection," the one series of mental facts which can alone be directly observed by the individual psychologist. Studies of the sorts (1) and (2) can be made by all properly equipped observers together, and in presence of what are called the "same" external facts. Studies of the sort (3) each psychologist must make alone for himself; but by the aid of the facts acquired through studies of the sorts (2) and (3) he can indirectly compare his introspective results with those of other psychologists. The first two sorts of study are very greatly furthered by what we know of the nervous system, but are by no means confined to this region of knowledge. Psychology is by no means a branch of neurology. On the contrary, wherever, in the physical world, any mind gets intelligible expression, or any physical conditions appear to determine mental states, the psychologist finds what he wants, in so far as he seeks means of comparing his introspective observations with the experiences of other minds.

Essentials of Psychological Study.

§ 10. The foregoing conditions already serve to define the principal methods of psychology, whereof we may next name the most important.

Methods of Psychology.

(1) Our first method—*the study of the expressive signs of mental life*—is in some forms extremely familiar to the popular mind. Every per-

son of any experience is his own psychologist in judging almost constantly the ideas, moods, and intents of his fellows by watching not only their faces, but also their whole range of voluntary and involuntary expressive movements. The relatively scientific use of such study as a method of more careful psychological investigation depends both upon extending the range of its application and upon rendering more minute the scrutiny employed.

The naturalist employs this method when he studies the minds of animals through an observation of their behaviour and of their skill. It should be carefully remembered, however, that not merely the passing functions of the moment, but the established habits and the permanent physical productions of any animal are of importance as outwardly expressing its mind; and a similar thing holds of physical facts and processes that express the coöperative work of many intelligent beings. Works of art, institutions, languages, customs, faiths, cities, national life in general—all these things and processes are instances of complex expressions of mental life in outwardly observable physical forms.

The inevitable dangers and difficulties of this, the most constantly employed of all the methods of studying minds, are meanwhile, in part, well known. The facts to be studied are very numerous and complex, and easily misjudged, especially in case of minds that are markedly different from our own. A good example of this difficulty is the common failure of even very intelligent men to understand a good many among the expressive functions of women, or the similar failure of women to comprehend a great many among those of men. The barrier of sex will probably prove a permanent hindrance, in some important directions and regions, to the progress of the scientific study of the human mind, so far as that study seeks to make the mental life of one sex fully comprehensible to psychologists who belong to the other.

(2) The second method of the psychologist begins by proceeding backwards from the study of the outwardly expressive functions, in which our mental states get a sort of embodiment, to the scrutiny of their nervous conditions. These, once found to be, as they are, centred in the organisation and in the functions of the brain, this second method develops into that of the *study of the relations that exist between mental life and brain processes.* This method is necessarily an indirect one. It takes very numerous special forms. One of these is furnished by the study of nervous diseases with reference to those changes, in the expressive signs of mental life, which are the result of whatever form of nervous disorder is each time in question. In so far as the phenomena of insanity are already, despite our defective knowledge, traceable to otherwise known and definable physical disorders of the nervous system, the study of such phenomena for the purpose of the psychologist also obviously belongs here.

A further extension of the present method is offered by those experiments upon the nervous systems of animals which involve any noteworthy and intelligible changes in the signs of mind which these animals show. And it is thus that the functions of the brain have been frequently and very fruitfully studied during the last twenty-five years, despite the difficulty of drawing exact conclusions as regards the human brain and the human mind from the interpretation of such experiments. Nor does the use of the present method cease here; for, apart from disease and from vivisection, we are able to perform an experiment upon the functions of the brain whenever (as by stimulating our sense organs in particular ways) we can harmlessly bring about any physical change in a living man, whose mental life can indirectly be studied through his own accounts of it, while the physical effect that the experiment has upon his brain functions is meanwhile capable of a more or less determinate estimate. It is in this way that we study what is sometimes called "the physiology of the senses."

§ 11. (3) In close connection with the first, and in frequent connection with the second of the foregoing methods, stands the *method of introspection*, by which the individual psychologist *undertakes to observe and to analyse his own mental states and processes.* If carried on alone, without constant reference to the physical conditions of the mental life observed, and without a frequent comparing of notes with one's fellows, introspection can accomplish little of service for psychology. But, in union with other methods, introspection becomes an absolutely indispensable adjunct to all serious psychological study. The man who has never observed within will never be able to interpret the minds of others. The student of neurology can directly contribute to psychological science only in case he learns to scrutinise carefully his individual mental processes, even while he indirectly learns about their nervous conditions. Introspection is, however, for the scientific psychologist, despite its importance, rather to be used as an auxiliary of the other methods than as a method capable of leading the way. However expert a man may be in his own mental states, it takes a wide intercourse with his fellows, an outwardly observant examination of the signs of mind in others, and a careful study of the physical conditions in which given mental states arise, to reach any conclusions worthy of scientific consideration. The truly great "introspective psychologists" of the past, from Aristotle down, were none of them, as psychologists, at all exclusively devoted to the study of their own personal experiences. They were, for instance, greatly influenced both by the traditional views of their social order and by the popular psychology which lay more or less concealed in the languages that they used.

Introspection.

(4) An important modern method, which unites or may unite features

belonging to all the foregoing methods, is the method of *psychological experiment* in the stricter sense. This method involves *bringing to pass mental processes of greater or less complexity* (acts of attention, simple acts of will or of more complex acts of choice, associations of ideas, processes of memory or of computation, emotional states, etc.) *under conditions which can be exactly controlled or determined.* Then, according as he wishes, the psychologist studies one or more of the various noteworthy aspects of the situation that has been experimentally brought to pass. Thus one can examine by direct introspection what goes on in a single observer under the circumstance of a given experiment. Here one takes advantage of the definiteness which the experimental devices may give to the whole experience. Or again, in a series of related experiments, one can introspectively note how the mental states or processes alter as the physical conditions undergo certain determinate variations. Further, through comparing the reports, or the other expressive signs which various subjects give of what goes on in their minds under similar experimental conditions, one can get results as to the contrasts that exist between the mental life of various people. In some cases it is also possible to determine, to a certain extent, what physical changes in the central nervous system are produced by the experiment, and thus our knowledge of the relations of particular nervous and particular mental states may be furthered.

Psychological Experiment.

Very important results have also flowed from the careful noting of the various time-relations of any or of all the foregoing classes of facts, as they occur when exact experimental conditions have been established. The problem, how long a given mental process takes, and how this time-element varies with given variations in the situation, is one of great interest to the psychologist. Experimental psychology is the most recent of the branches of psychological work. In general it has to be carried on in special laboratories, where there are instrumental means for measuring time-relations, as well as for determining precisely the physical conditions under which the mental processes to be studied take place.

II. THE PHYSICAL SIGNS OF THE PRESENCE OF MIND.

§ 12. In view of what has now been said about methods, we may best begin our analysis of the general characteristics of mental life by asking what are the most general classes of expressive signs by which the living beings that have minds manifest to us their mental life. How, then, do those animals which are high enough in the scale to show us that they certainly possess mental life, differ from those living beings which, like the plants, give us no such manifestations?

The most general answer to this question is, on the whole, not very difficult. When a cat watches for a mouse, when a dog finds his way

home over strange country, we do not doubt that here are real signs of the presence of mind. When a tree that is cut with the axe shows no sign of feeling the blow, we note that here signs of mind are absent. To be quite certain just where to draw the line between living beings that seem to have no minds and living beings that possess minds does indeed involve us in great difficulties. But there are some general signs of mind which we all regard as unmistakable, and some cases of lack that seem to us to exclude the presence of any functions such as the psychologist studies. The general signs of mind may be defined as follows:

General Signs of Mind.

In the most general way of viewing the matter, beings that seem to us to possess minds show in their physical life what we may call *a great and discriminating sensitiveness to what goes on in their environment.* And by this their sensitiveness we here mean something which, though a sign of mind, is itself purely physical—viz., a capacity, observable from without, to adjust themselves by fitting movements, or by their internal physical functions, to what takes place near them. This sensitiveness is called *discriminating* because it is never a mere tendency to respond to every sort of change at random, or to all effective changes in the same way; but it is a tendency to respond to some changes (*e. g.*, light or sound) rather than to others, and to various changes in various fitting ways. To be sure, plants also show very many signs of well-adjusted responses to the changes in their environments. And, even so, those functions of animals which need show no signs of any mental accompaniments (*e. g.*, gland secretions, or the regulation of the body's temperature) are also discriminatingly sensitive, in the physical sense, to external conditions. But the matter is here first one of degree. Greater, quicker, or else more highly elaborate, is the sensitiveness of the beings that have minds, as it is shown in their expressive functions. Duller, or slower, or else simpler, appears the physical sensitiveness of the non-mental being or function when the environment changes.

§ 13. But it is not merely this very general difference in degree which we note when we consider this discriminating sensitiveness as a general sign of the presence of mind. If we come closer to the facts, we next note that the general sensitiveness of the beings that have minds determines itself, as we watch it, in three ways, and so appears in three important aspects, each one of which has its own special degrees of manifestation:

(1) The sensitiveness of the psychically endowed beings manifests itself by what, with a ready sympathy, we easily interpret as signs of satisfaction or of dissatisfaction, of pleasure or of pain, and of various emotions. These signs, in their simplest forms, are so well known that we need hardly describe them. Where, as

Signs of Feeling.

in the earthworm, we can detect nothing that we ordinarily call intelligence, we seem clearly able to note the signs of pain. Writhing, withdrawal from a source of injury, and other simple movements of an obviously protective character, are such elementary signs of dissatisfaction. Still other movements, even in very low forms of life, seem to indicate satisfaction. Higher up in the animal scale we meet with reactions of fear, of anger, of joy, of the more elaborate forms of desire, and, in the end, of numerous other emotional states. We may for the present class all these as the SIGNS OF FEELING. The beings that have minds thus seem to us, from the first, *to show signs of more or less immediately valuing, or estimating, their own state, or their own relation to their environment.*

Signs of Intellect.

(2) But a still more noteworthy aspect of animal sensitiveness, appearing in simple forms, decidedly low down in the scale, becomes, in certain lines of evolution, rapidly more and more important higher up, and reaches its highest expression in man. The animal, and especially the vertebrate animal, in proportion to its elevation in the mental scale, *shows a disposition to be moulded in its actions by its successive experiences.* That is, it is not merely sensitive in particular ways to particular changes; but *it learns by experience.* What response it makes at any given time is determined not merely by its inherited structure, nor yet by what is now happening to it, but, in addition, *by what has happened to it before*, during its intercourse with its world. This capacity to be moulded by experience greatly elaborates the discriminating sensitiveness of the organism that is able thus to learn. Wherever this capacity appears in its higher and more complex forms, the signs of such plasticity, of such power to be taught by the world in which the animal lives, constitute, when taken together, the SIGNS OF INTELLECT.

Special Marks of Higher Intellectual Life.

It is true that, in ourselves, nervous functions which seem to have no mental aspect, are still often moulded by experience. Not every case, then, of this sort of plasticity is itself a sign of mental life. In fact, all the so-called "acquired characters" of animal organisms plainly involve, in some measure, a capacity to be moulded by physical experiences. But, once more, the matter is one of degree. The power to show the effects of past experience is, in its more elaborate forms, the most convincing of all the signs of the presence of mind. Especially convincing is this sign when it appears as a power to apply the results of former experience in the adjustment of an animal's actions to decidedly novel conditions. When wild animals, after having experienced something of the nature of traps, become especially skilful in detecting and avoiding new sorts of traps, we never doubt that this is a sign of real intelligence. When (as

is narrated in an account quoted by Romanes) an elephant, taught to pick up articles and hand them to the man who is on his back, detects at once, even in case of a novel article (*e. g.*, a sharp knife), and by virtue of some subtler similarity of this novel article to previously known things, will either pass up this article carefully or with a careless haste, we are sure that this sort of acquired skill indicates the presence of mental life of a highly developed sort.

Instinct.

Decidedly different is the case where the actions of an animal show great skill in their successful adjustment to surrounding conditions, while, nevertheless, the adjustment in question seems to be largely an original function of the animal, which is only in part, perhaps in very small part, moulded by the animal's own past experience. In this case we call the actions that we observe cases of INSTINCT. The signs of instinct cannot of themselves be regarded as signs of what, from the psychologist's point of view, is identical with intellect. The most marvellous developments of instinctive functions occur in invertebrate animals, especially among the insects (*e. g.*, ants, bees, and wasps). While these instincts get adjusted to passing experience, they are sometimes remarkably perfect apart from the influences of any past experience. The instincts of the higher vertebrates are generally a good deal moulded by the experiences of the individual animal, so that although a large part of the functions may be directly inherited, it is nevertheless subject in its growth to the laws of the intellect, and is here seldom free from great modifications during the life of its possessor. In man the inherited instincts, although they lie at the basis of all our intellectual life, get so much modified and moulded by our experience that we generally fail to recognise their presence as instincts. Yet, as James and others have shown, man has at the outset an extremely large number of elaborate and inherited instinctive predispositions to given sorts of conduct.

In so far, however, as we leave out of account these relatively unalterable inherited instincts, we can then say that by the signs of intellect we mean those which show an animal's *plasticity in the presence of experience, and especially its skill in adjusting the results of past experience to the meeting of novel situations.* This, then, is the second form of that general sensitiveness which constitutes the sign of the presence of mind.

Signs of Will.

(3) In a third form the general sensitiveness of the beings that possess minds shows itself when we consider, not now the conditions, but *the results of their actions* and their own relations thereto. Not only do they respond to slight changes, but, in many cases, their responses lead to highly important results, whose elaborateness seems out of all proportion to the slenderness of the causes that have set them into activity. For one thing, the higher animals generally show an *overwealth of activity.* They not only

respond in a fitting way to their environment, but they repeat or elaborate their responses more than is necessary for adjustment. They move about when they might, without loss or danger, keep quiet; they sing, as the song birds do, apparently often for the mere love of singing; or, in the form of play, they vent their surplus energy as kittens do, or as children. On another side of their active life we find a great many of them *highly constructive or destructive. They do not leave their world as they found it. They fashion their environment to their pleasure.* They build honeycombs, nests, houses, cathedrals. Or, as beasts of prey, they destroy others, and so may alter the aspect of their environment very effectively. Now, when such activities, whether by their overwealth or by their elaborateness, or by their permanent or by their far-reaching results, so attract our attention as to seem to us to show that *the animals concerned take note of their own conduct, and more or less clearly mean or intend its outcome*, we regard these as SIGNS OF WILL. The life of the will means the life of an animal, in so far as it involves a more or less *conscious direction of conduct.*

In this way, then, we get three sorts of noteworthy signs of mind:

(1) THE SIGNS OF FEELING—*i. e.*, the signs of an animal's way of directly valuing or estimating its own state, or its relation to the environment.

(2) THE SIGNS OF INTELLECT—*i. e.*, the signs that indicate an animal's tendency to learn by experience.

(3) THE SIGNS OF WILL—*i. e.*, the signs that an animal is taking account of its own conduct and directing this conduct.

III. THE NERVOUS CONDITIONS OF THE MANIFESTATION OF MIND.

§ 14. The organic conditions for all these manifestations of mind is the presence of a nervous system. At all events, such signs of mental life as some have believed to be present in organisms too low to show us any differentiated nervous systems are such as to need here no further mention. The discriminating sensitiveness which everywhere accompanies all the higher manifestation of mind is, physically speaking, a property of nervous tissue.

Mind and Matter.

Leaving to the anatomist and the physiologist every extended description of the structure and functions of our nervous system and of its instruments—viz., the sense organs and the organs of muscular movement—the psychologist can here only try to show very summarily what characters of the nervous system most interest his own undertaking.

The nervous system consists, for our purposes, of a vast collection of "elements," each one of which is a "nerve-cell" that, in addition to its minute central mass, possesses prolongations which are either "nerve-fibres" or else are other so-called "processes"—viz., minute and multi-

formly branching extensions of the substance of the nerve-cell. These processes, extending, in the central nervous system, from one cell to the immediate neighbourhood of other cells, form an extremely complex network of finely divided threads or of moss-like or of mould-like collections of short and long threads and branchings. A current and authoritative opinion holds that the processes of one cell probably never really unite either with the processes or with the central substance of any other cell. Thus each cell, with its processes, lies, it would seem, side by side with other cells, whose processes, intertwining like the foliage of neighbouring trees with its own processes, still never grow into its own substance, so that all these "elements"—*i. e.*, cells, each with its own extensions—are anatomically independent. The nerve-fibres proper, which grow out of what are called the axis-cylinder processes of cells, run often for long distances unbroken through the nervous system, either reaching their various terminal organs in the outer or "peripheral" portions of the body, or else coming to an end in tuft-like branchings in the immediate neighbourhood of the cells whose functional relation to their own parent cells they are destined to determine. Nerve-fibres often divide into branches of equal value, or else send off, in their course through the central regions of the nervous system, many accessory branches, which may terminate as does the main fibre, only at points often far removed from one another. Thus any given fibre, with its branches and accessories, may serve to bring its parent cell into some sort of relation to many other regions of the central nervous system. On the other hand, the anatomical independence of the elements which has thus been probably made out suggests that every cell has some sort of relative and subordinate independence of function. When it has once received any disturbances it probably sends out, through its processes and its fibre, its own sort of excitation; but very possibly this excitation does not pass over from the terminations of the cell branches to any other nervous element without considerable alteration in form, and perhaps in degree. It has been suggested by the experimental work of several neurologists that what a cell does to its neighbours or to the more distant cells with which its fibres bring it into relation must be somewhat analogous to "induction" as known in case of electrical phenomena. From this point of view the excitation of a cell through the excitation of its nerve-fibre or by any other means may "induce" other cells, with which the first cell stands in relation, to give out, in their turn, their own form of excitement, which they then pass over by induction to yet other cells. In any case, the known general structure of the nervous system seems especially adapted (1) to the manifold propagation of excitements in various directions, (2) to the constant variation of the form of this excitement as it passes from element to ele-

Structure and Function of the Nervous System.

ment of the nervous system, and (3) to the most complex influence of the excitations of one part of the nervous system upon the independently aroused excitations which happen to be present in other parts of the system.

Sensory and Motor Functions.

§ 15. The best-known division that exists in the functions of the nervous system is that between the sensory and the motor functions. Beginning in the more external or peripheral regions of the organism, disturbances are constantly passing inwards from the sense organs, where the fibres of the sensory nerves have their outward endings. These sensory fibres carry physical disturbances of some still unknown form to the neighbourhood of more centrally situated cells, which in their turn may, and in general obviously do, send the excitation or its induced resultants to very various parts of the still more centrally situated nervous tissue. The rate at which the nervous disturbances are carried in nerves is in general known, although not so accurately in the sensory as in the motor nerves, and is from thirty to forty metres per second. In the meantime, centrally initiated physical disturbances are constantly passing outwards over motor nerves to the terminations of these nerves in muscles, glands, etc., where these disturbances produce complex effects upon the organs of voluntary and involuntary movement, upon the circulation, and upon the secretions. In general, the sensory nerves, in view of their actual relations to the rest of the organism, are so disposed as to carry disturbances only inwards, and the motor nerves so disposed as to carry only outwards, although this law seems to be not absolute, but only a resultant of the usual conditions.

Sense Organs.

The sensory nerves terminate outwardly, as has just been said, in sense organs, which are in general so constructed as to expose their nerve-fibres to only one sort of physical excitation (as the fibres of the optic nerve are normally exposed to the effects which light produces upon the retina, the auditory nerve to the effects of sound-waves, etc.).

This division between sensory and motor nerves is, in the first instance, a purely physical matter, and does not by any means name functions that must have any direct relation to our mental states. For disturbances travelling inwards over sense-nerves need not be passed on through the nerve-centres until they reach the level of the cortex of the brain; and unless they do reach the cortex we have no sensations, and the sensory-motor process then goes on without mental accompaniment. Just so, very numerous motor currents pass outwards from centres—*i. e.*, from groups of cells situated wholly in the spinal cord or elsewhere below the level of the cortex—and are in no wise due to excitations aroused in the cortex. In such cases the motor processes in question have no relation to our will. A pigeon deprived of its brain hemispheres can fly, avoiding obstacles; can

perch, balance, walk, etc., when stimulated to such acts by appropriate sensory disturbances. It, however, no longer shows hunger, fear, love, or similar sorts of discriminating sensitiveness, and gives no sufficient signs of such intellectual life as would characterise an uninjured pigeon. If left alone, it rests in apparently absolute repose and indifference to its environment. Driven from one perch, it merely flies till it finds another. Thus the sensory excitations which reach the brainless pigeon's nervous centres produce, probably apart from any definite mental life, physical disturbances of cells, such as stimulate in an always rigidly determined serial succession (through the intermediation of motor nerves) just the right muscular fibres which are needed to produce each time the pigeon's acts of balancing, flying, or perching. Yet all this appears, in the end, to involve none of the watchful, often hesitant, tremulous, emotionally busy sensitiveness of the normal pigeon. The brainless pigeon seems like a delicate but absolutely determined machine, which never really seeks to escape, and never shows the least normal concern for its own preservation, but merely perches when it touches a perch, flies when it is in the air, balances when it begins to fall—and all this with the stubbornness of a steadily working clock.

Adjustment to the Environment.

So far, then, a sensory impression has appeared in our account as a physical disturbance that passes inwards from a sense organ over a sensory nerve. In the central masses of cells such disturbances, occurring, as they do, at any moment, in great numbers, produce changes that are often far-reaching, but that are usually determinate as regards their total outcome, and that often are so quite apart from any signs of intellect, of feeling, or of will. In any case, however, the outcome, if definite, is some sort of "adjustment to the environment"—*i. e.*, is of a nature to be, in general, serviceable to the life of the organism. The adjustment is modified by the endless interchange of excitations throughout the central nervous system, whose enormous numbers of relatively independent "elements," mutually inducing different forms of excitement in one another as soon as any of them are disturbed, tend both to the multiplication and to the control of the effects of every disturbance. The useful movements that result are such as they are because, in the end, groups of muscle-fibres get excited in a definite serial order for every complex act. And this serial order is determined by the total structure and the consequent functions of the central nervous system.

Brain Processes.

§ 16. But now, where the signs of mind are definitely shown, the accompanying nervous processes are still of the same fundamental sort as in the cases just discussed. The difference lies in the place, in the complexity, and in the significance of the central nervous processes involved. When, as in our own cases, the cortex of the

brain is present and is actively functioning, it functions as it does because of the current sense disturbances which reach it. The result of the brain process is always an outward-flowing but very highly orderly—a serially arranged—collection of disturbances which, acting, in general, through the co-operation of lower centres, result either in actual external movements, or in tendencies to movement, or, finally, in the prevention of movements which would be carried out, at the time, by the lower centres, if the latter were not under the control of the brain. Intermediate between the ceaseless income of the sensory disturbances that reach the cortex so long as it is active, and the equally ceaseless outgo of the motor processes (or of the processes tending to the control of movements), that leave the cortex all through our waking life, there are central processes occurring in the form of an interchange of induced cellular disturbances among the elements of which the cortex of the brain is composed. As there are probably some hundreds of millions of these elements in the grey matter which forms the surface of the brain, and as the intertwining foliage of the branching forest of cell processes, together with the masses of innumerable winding fibres that wander from region to region of the brain, must determine an august multiplicity of interrelations among these elements, it is no wonder that these central processes should show a simply inexhaustible complexity. Still more marvellous, however, from a purely physical point of view, is the orderliness which reigns amid the complexity. This orderliness is, in general, due to the great law of habit.

Habit. *The brain tends to do the sort of thing that it has already often done.* The brain is, meanwhile, persistently retentive of its own once-formed habits regarding these interchanges of the activities of its various elements whenever they are excited in particular ways. And it is thus persistent to a degree which we can never cease to regard with more wonder the more we study the brain's functions. On the other hand, the cortex remains, to a remarkably late period in life, persistently sensitive to a great variety of new impressions, and capable of forming at least a certain number of specialised new habits—such as are involved whenever we learn to recognise and name a new acquaintance, or to carry out a new business enterprise. And all these things, it must be remembered, the cortex accomplishes as a physical mechanism. If we change—by experimental interference, by accident, by poisoning, by disease—any of the physical conditions of the cortex, we interfere with some or with all of these functions. Meanwhile, if we at any time were to cut off all sensory stimulations, the brain, as many facts indicate, would either soon cease to act at all, or would remain active only in a slight or in an almost utterly insignificant way. On the other hand, so long as the brain is active it sends out motor stimulations, or stimulations that tend to control or to suppress the activities guided by lower centres. And it

is precisely this motor outgo of the brain that determines the very signs of mind which we discussed above.

Furthermore, while the brain is, during waking life, full of general activity, it is now well known that every definite outflowing process, as well as every definite sensory stimulation, involves sharply localised regions of the brain. Eye and ear, arm and leg, have definite centres in the brain corresponding to the stimulation of the sense organ, or to the movements of the limb. *Each of the numerous habits of the brain means, then, tendencies to the excitement of localised tracts and paths under given physical conditions.* An excitement passing over one set of paths leads to one system of external movements—*e. g.*, from eye-centre to hand-centre, when one sees and then grasps. If circumstances vary the paths, they vary the motor results. It is possible to have, in cases of localised brain disorder, the survival of a few very complex habits of movement in the midst of the utter wreck of all the other related habits of the same grade of complexity and of similar significance—as when a patient loses all power to remember his native tongue except for a few surviving words, chosen by the disease, as it were, either at random or in more or less typical fashion, to outlast the rest. In this case a few definite and localised habit-worn paths for the induction of activity remain after all the related paths of the region in question have been destroyed.

Meanwhile, what the brain at any moment does, in answer to the current sensory stimulations, is determined both by its entire past history and by its inherited "temperament" or original type of structure. For by heredity the brain has come to be just this vast colony of functionally united cells. And, on the other hand, whatever has happened to the brain in the past has meant some definite and usually sharply localised interchange of induced activities among its elements. Every such interchange has altered the minutest structure of all the elements concerned, has established localised paths between them for future inductions to follow. They can never act again precisely as they would have done had they not acted once in just this way. And this is what is meant by saying that the brain *forms its habits.* One must now, in addition, note that this formation of habits occurs in the most subtle fashions. Parts that have often functioned together tend to function more easily together again. This is true down to the minutest detail of localised functions. But what is still more significant for all our higher mental life is, that *general forms or types of activity, however subtle or evanescent their nature, when once they have resulted from a given exchange of induced activities (due to sensory stimulations), tend thereby to become henceforth more easily re-excited, so that the habits of our brain come to be fixed, not merely as to the mere routine which leads to this or to that special act, but as to the general ways in which acts are done.* A given "set" of the

brain as a whole, a given sort of preparedness to be influenced in a certain way—yes, even a given tendency to change, under particular conditions, our more specific fashions of activity—may thus become a matter of relatively or of entirely fixed habit; so that, under given conditions, the brain, so long as it remains normally intact, is sure to respond to certain sensory disturbances by assuming this "set," by being ready for this relatively new influence, or by actually seeming to change even its specific past habits themselves in a certain general but habitually predetermined direction whenever given sorts of stimulation are presented. It is known, for instance, that "fickleness" of conduct, irrational change of plan of behaviour, can itself become a hopelessly fixed habit in a given brain. There is, then, no type of activity so general that some brain cannot be trained to become habitually and fatally predetermined to just that type of interchange of internal functions, and so to that type of outward-flowing activity.

Brain Centres and Lower Centres.

§ 17. On the general relation of the activities of the cortex to those of the lower nervous centres, and of the relations between various activities of the cortex itself, it still remains to say here a few words. The brain cortex directs, by itself alone, and apart from the co-operation of lower nervous centres, few or no externally observable motor processes. What it does is partly to combine and elaborate, partly to guide by slight alterations, and partly to hold back or to prevent, the activities which other centres, left to themselves, would carry out in response to the sensory stimuli which either reach them or for which the brain substitutes its own sort of stimulation when it arouses the lower centres to act in its service. The character of the cortex as an organ for preventing or "inhibiting" the functions of lower centres is of very great importance, and well exemplifies the sort of hierarchy which obtains among our nervous centres. Within the brain itself a similar hierarchy exists, and a similar system of mutual inhibitions gets formed on the basis of our experience.

Inhibition.

Upon this process of "inhibition"—*i. e.*, of the prevention or overcoming of one form of nervous excitement through the very fact of the presence of another—the organisation of all our higher life depends. What, in any situation, we are restrained from doing is as important to us as what we do. Tension, the mutual opposition and balancing of numerous tendencies, is absolutely essential to normal life. The brain receives, at every waking instant, an enormous overwealth of sensory stimulation. For instance, the habits of those portions of the brain which receive the fibres of the optic nerve, and of those portions which direct our eye-movements, are such that every object of the least note in our field of vision actually acts as a stimulus to incite us to look directly at itself. Consequently, if the eyes are idle, the presence

of any one bright light in the otherwise indifferent field of vision is a physical disturbance, to which the natural motor response is the turning of the eyes towards that light. And so, if the field of vision is full of interesting objects, all of them thus tend to excite various motor responses on the part of the eyes. In order to look steadily, for even a moment, in any one direction, we therefore have to inhibit all of these tendencies except the one whose triumph means seeing the preferred object. This is only one among the countless cases where the accomplishment of a given act means the inhibition of other acts to which the brain is meanwhile incited by the presence of some habitually effective stimulation.

As every normal stimulation that reaches our brains during our adult years is likely to appeal more or less vigorously to some established brain habit, the need of such suppression of possible motor processes is absolute and continuous. The problem of the inhibition of those habits of movement whose presence at any given moment would injure the useful adjustment of our organisms to their environment is, despite its complexity, solved, in case of all the higher nervous centres, by the presence of certain general and very characteristic physical processes whose nature is still very ill understood, but whose beautiful adaptation to their purpose we can already to some extent estimate. We have before spoken of what may be called the general "set," or "sort of preparedness for a given kind of excitation," which the brain at any moment may be brought to assume. This "set" is in general itself the obvious result of a previous series of sensory stimulations, and of an appeal to old habits, and it may come to pass either suddenly or quite gradually. Once assumed, any given "set" of the brain manifests itself by the fact that, for the time, one group of sense-experiences tends to arouse the motor habits that have become attached to them in consequence of the past experiences of the brain, while the motor habits to which all other current sense-impressions appeal, are in great measure inhibited. Yet these relatively ineffective sense-impressions certainly reach, in most cases, their centres in the brain, for if altered a little from their current character they may at once assert their presence by calling out movements that show concern in the alteration. A similar "set" may be given by the action of the brain to a group of lower centres, which then proceed to react automatically to external stimuli until the whole process is cut off by external stimuli, or by a new signal from the cortex; and while this "set" continues all other motor habits of the centres in question are inhibited.

Set of the Brain.

§ 18. Examples, both of inhibition in general and of its relation to the passing general "condition of preparedness" of the higher and lower centres, are easy to give. In general, all higher intellectual processes are accompanied by processes in the cortex which appear, when seen from

without, enormously inhibitory. One absorbed in writing or reading lets pass without response countless impressions which pretty certainly reach the brain, impressions to which, under ordinary circumstances, he would respond by acts of looking, of listening, of grasping, or of other more or less useful or playful types of adjustment. Let him cease the higher activity, and he adjusts himself more vivaciously to the lesser matters of his environment. An absorbed public speaker, an actor, or a man in a formal social company, inhibits those movements, however habitual they are in other company and however strong the momentary sensory solicitation to them, which his habits have taught him to suppress as being here "out of character." This word "character" here names the mental equivalent of a given "set" of brain. So long as one assumes the "character" the well-practised inhibitions triumph. If one goes home, or changes one's company, those former reactions may vanish as if they never had been, and it may be even impossible to reassume them, except in particular surroundings. In case of the relations of higher and lower centres, the "set" of a group of lower nervous processes is well illustrated by the activity of walking, which consists of a regulated series of motor adjustments to sensory stimulations—leg-movements, acts of balancing, etc. This series is largely under the control of relatively lower centres, both in the cortex and below. It may be initiated by a signal from above. Once begun, it is continued, with a consequent inhibition of all inconsistent muscular movements, and often little or no guidance from the more complex groups of brain centres, until the signal to pause is given. Then other activities of adjustment take the place of the ones that have come to an end. Thus one pauses in a walk through a garden to survey more carefully the appearance of the flowers, to do a piece of work that requires the skilful use of the hands, etc. The rule of inhibition, as regards the before-mentioned hierarchy of the nervous centres, seems to be that the higher a given function is, the more numerous are the inhibitory influences that it exercises over lower centres. Intense brain activity of the highest sort is opposed, while it lasts, to nearly all the simpler functions above the level of the vital necessities, except the very few, such as reading or speaking, which training may have brought into the direct service of the highest activity itself. Excite a child's brain to anything approaching absorbing activity (*e. g.*, by telling the child an interesting story), and for the time you "keep him quiet." Otherwise he runs about, looks here and there, laughs, wriggles, kicks, prattles—all adjustments to his environment, adjustments either useful or playful, but of a simpler sort. These may cease by inhibition when the story begins. The child may then sit for a short time with moveless hands, with optic axes parallel—*i. e.*, with eyes "gazing far off," with legs hanging loosely, with falling lower jaw—all of them more or less inhibitory phenomena.

§ 19. The practical consequences of this general principle of the inhibitory character of the higher nervous processes are multitudinous.

Self-control.

Absence of inhibitions is a familiar sign of nervous disorder or degeneration, and also, in children, of immaturity. "Self-control" is an essential part of health. This principle furnishes the reason why so much of our educational work has to be expended in teaching "self-control," whose physical aspect is always the presence of inhibitory functions. The moral law has often been expressed in the form of the well-known "*Thou shalt not.*" Such negative precepts always presuppose that in the person who really needs to be taught by the precept, a disposition or habit of brain pre-exists which involves, when left to itself, a certain sort of response to a given environment—*e. g.*, in an extreme case a tendency to the expressive acts called, in human social relations, theft or murder. Instead of telling such a man what positive motor activity to substitute for such doings, the negative precept undertakes to point out that, as a condition prior to any better adjusted conduct, these motor tendencies, at least, must be inhibited. But their inhibition is to be actually brought about, in case of the successful moral precept, through the influence of what is called in psychological language "suggestion." The physical efficacy of such "suggestion" depends, however, upon its appeal to brain habits of a very high level, which, like the other higher processes, have a general capacity to act in an inhibitory sense, as against functions of lower levels or of a more primitive simplicity.

Suggestion.

But just as we often train habits of inhibition as a preliminary to the more positive establishment of useful higher functions, it is even so true that, whenever we can get higher functions of a positive sort established, we thereby train inhibitory tendencies. And, on the whole, this is the wiser course for the teacher of the growing brain to take where such a course is possible. Inhibition is a constant means, but it is still but a means to an end. The end is the right sort of motor process. You teach a man to control or to restrain himself so soon as you teach him what to do in a positive sense. Healthy activity includes self-restraint, or inhibition, as one of its elements. You in vain teach, then, self-control, unless you teach much more than self-control. The New Testament statement of "the law and the prophets" substitutes "Thou shalt love," etc., for the "Thou shalt not" of the Ten Commandments. A brain that is devoted to mere inhibition becomes, in very truth, like the brain of a Hindoo ascetic—a mere "parasite" of the organism, feeding, as it were, upon all the lower inherited or acquired nervous functions of this organism by devoting itself to their hindrance. In persons of morbidly conscientious life such inhibitory phenomena may easily get an inconvenient, and sometimes do get a dangerous intensity.

Healthy Activity.

The result is then a fearful, cowardly, helpless attitude towards life—an attitude which defeats its own aim and renders the sufferer not, as he intends to be, "good," but a positive nuisance.

Variation of Labour.

The practical problem as to the degree of inhibition which it is well to establish in our nervous life is one which wholesome people meet in part by the device of a duly changing or alternating activity of the central nervous system. *The strain of absorbing intellectual work is, in considerable part, pretty obviously either conditioned or intensified by two factors:* (1) *The actual nervous expenditure involved in the inhibitory processes themselves:* While one works, countless excitations tend to set free lower motor functions, and all these tendencies have to be held back by countersignals from higher nervous stations. This in itself involves a great deal of motor expenditure. "To sit still" is itself, in general, a motor process, and is often a very hard one—*e. g.*, when one is in an exciting or harassing situation, and when prudence says: "Do nothing; wait and see." (2) *The indirect effects of non-exercise of the inhibited functions:* to sit still and think, to restrain ourselves, means to condemn many groups of muscles to inactivity. This means a tendency to disturbed nutritive processes, and so in the end an unequal development or an actual degeneration of the whole organism. We relieve the strain as well as favour the neglected organs when we substitute exercise for inhibition. Variation of labour is thus, in itself, and within limits, actual motor rest or recreation. "To let ourselves go," within the bounds of propriety, duty, and moderation, involves a rest from the heavy motor task of "holding ourselves still." This is especially true in children, in whom the inhibitory processes are ill-formed, and therefore the more laborious. Young children should never be asked to continue long any one type of inhibitory process. With them any one persistent "set" of the brain becomes very soon an injurious incident.

Worry.

On the other hand, not every change of the "set" of brain is itself restful. The phenomena of "worry" include many "changes of mind"—*i. e.*, of more special "set" of the brain. Yet the result is disastrous. But the effects of worry seem to be very largely due to the strong tension existing in the worried person between his abnormally numerous sensory incitations to particular acts and that general "set" of his brain which, so long as he is worried, survives all his actual changes of special "set" or plan, and tends to inhibit all sorts of definite or connected activity. Whether he rushes about or lies still in pretended rest, whether his mood is this or that, he is all the while incited to act, and is busy holding himself back from effective action. His endless question, "What shall I do?" his motor restlessness, his petty and useless little deeds, all express his inability to choose between the

numerous tendencies to movement which his situation arouses. Countless motor habits are awakened, and then at once suppressed. In his despair he tries to inhibit all acts until *the* plan—the saving plan—shall appear. And so, accomplishing nothing, he does far more motor work than an acrobat. But let the dreaded calamity over whose mere possibility he worries actually befall him. *Then*, indeed, there is often but one course of conduct, perhaps a very simple one, suggested by his new situation. The useless inhibitions vanish. One definite "set" of brain is, indeed, substituted for the preceding state, but the new one is free from the over-numerous and violent special tensions between higher and lower centres and functions which characterised the former. The recently worried man may hereupon become cool, may wonder that he can bear the worst so much more easily than he could the uncertainty, and may by contrast find not only rest, but a kind of joy in the relief occasioned by the cessation of useless motor processes. Where the man himself has worried, it is thus often the part of the seemingly most cruel fate to rest him; and this the latter then does by cutting off the extra inhibitions in favour of an easily accomplished response to definite stimulations.

Attention to Inhibitory Process.

Finally, in this connection, it may be observed that when a given series of acts, involving a certain number of successive inhibitions, has to be accomplished, much more mental strain is involved and more weariness results, according as the inhibitions themselves have to be made objects of a more definite consciousness or volition. And the degree of strain increases very rapidly with the attention given to the inhibitory side of the process. Hence the hard labor involved in learning new adjustments, in acts of voluntary attention, and in conscious self-restraint generally.

IV. THE CLASSES OF MENTAL PHENOMENA IN GENERAL.

Consciousness.

§ 20. A certain proportion of the foregoing functional processes are attended by mental states. In general, our mental life, or, as it is often called, our consciousness, attends those processes which, while involving the cortex, are of a decidedly complex grade and of a relatively hesitant character, or which come in consequence of the graver interferences on the part of our environment. Our most perfect adjustments to our environment are accomplished unconsciously, unless we chance to become aware of them through their relations to what is actually concerning our conscious life. Our mental life, however, regularly attends (1) those of our habitual cortex functions which are at any time considerably altered to meet novel conditions, and which accordingly have, despite their skill, a relatively hesitant fallibility about them; (2) those of our functions which are considerably disturbed in their normal flow by the intensity or the novelty of the external stimu-

lation; and (3) those of our functions which, in relation to the other functions present in the cortex, have a physical intensity that exceeds the average of what is going on at the same time. For example, we are conscious when we think out a new plan, but we perform numerous acts of mere routine without noticing them. What we do very rapidly we fail to follow, in its details, with our mental life. What, as being somewhat novel, we do with "deliberation," we may follow very adequately. But the physical accompaniments of strong states of feeling, however swiftly they bring some reaction to pass, still imply a change in our consciousness. And intense experiences, such as disagreeable noises (the sound of a hand-organ or of a hurdy-gurdy), may long retain a place in consciousness which may be out of proportion either to the importance, or to the novelty, or to the complexity, or to the deliberateness of the motor functions which they arouse. Meanwhile, the precise conditions that mark the boundary between those functions which have no mental equivalents and those to which consciousness corresponds is unknown. What we are sure of is that our consciousness is a very inadequate representative of what goes on in our cortex.

The Stream of Consciousness.

§ 21. The mental life which accompanies these functions consists of a "stream of consciousness" in which we can generally distinguish many "states" or different "contents" of consciousness. These "contents" (or rather, as we shall see, certain distinguishable aspects of these contents) we divide, as before indicated, into three sorts: (1) Contents of Feeling; (2) Contents of Intellect; and (3) Contents of Will. The contents of Feeling form whatever constitutes the immediate value for us, of the passing experience, as satisfactory or unsatisfactory. The contents of Intellect are such as have to do with our application of past experience to the present facts. The contents of Will are such as have to do with our direction of our own activities.

§ 22. The "stream of consciousness" is the name frequently applied to what passes in our mental life, because, mentally speaking, we live in a state of constant inner change, so that no portion of our consciousness ever remains long without some alteration, while most of our contents are always changing pretty rapidly. On the other hand, the changes in our inner state are, in general, however swift they may be, still somewhat gradual when compared with the swifter physical changes known to us. A flash of lightning lasts very much longer for our sight than it does as a fact in the physical world. This is partly due to the "inertia" of the retina of the eye. But a similar "inertia" holds of all our central processes. Every mental experience always joins on, more or less, to subsequent experiences, and in general to previous experiences also. A new experience gradually wins our attention, reaches its height, and dies away as our attention is turned to the next; and even in very sudden experiences this

relatively gradual character of the process can be noted, if not at the beginning then at the end of the experience, as it slips away into a mere memory. If one listens to any simple rhythm, such as the ticking of a watch, one can note how the succession of separate ticks is viewed by our consciousness in such a way that the successive beats do not stand as *merely* separate facts, but are always elements in the whole experienced rhythm to which they seem to belong, while the successive presentations of the rhythm form a sort of stream of events, each one of which gradually dies out of mind as the new event enters. In consciousness there is no such thing as an indivisible present moment. What happens in our minds during any one thousandth of a second of even the busiest inner life none of us can possibly make out. The contents of mind, as we know them in the "psychological present," constitute at the very least a considerable and flowing series of changes, the least appreciable portion of which takes up a considerable fraction of a second.

As for these "contents" themselves of the stream of consciousness, it is well to say at once that they never form any *mere* collection of "ideas" or of other simple and divided states. Consciousness is not a shower of shot, but a stream with distinguishable ideas or other such clearer mental contents floating on its surface. What we find in any passing moment is a little portion of the "stream," a "pulse" or "wave" of mental change, some of whose contents may be pretty sharply distinguished from the rest, while the body of the stream consists of contents that can no longer be sharply sundered from one another. If one listens to music, the notes or the chords may, in their series as they pass, appear as sharply separable contents. But these stand out, or float, upon a stream of mental life which includes one's estimate of the time sequence of the music as a whole, one's pleasure in hearing the music, one's train of associated memories, one's general sense of the current bodily comfort and discomfort, and much more of the sort, which no man can analyse into any collection of separate or even separable states. In consequence, we are never able, by any device at our disposal, to tell with certainty the *whole* of what is, or just was, present to any one moment of our conscious life. The old question whether one can have "more than one idea at a time" present to one's mind is a question absurdly put. Present at any one time to one's mind is a small portion of the flowing stream of mental contents, in which one can in general distinguish at least two, and sometimes decidedly more, elements of content (perceptions, feelings, images, ideas, words, impulses, motives, hopes, intentions, or the like), while beside and beneath what one can distinguish there is the body of the stream or (to change the metaphor) the background of consciousness, where one can no longer distinguish anything in detail, although in some other moment one may easily note how the whole background has changed.

§ 23. As for the different sorts of contents, it is also well to say at once that they can be distinguished rather than separated. When we distinguish feeling—*i. e.*, the current direct sense of the present value of what is happening to us—from intellect—*i. e.*, the mental process of profiting by and using our past experience in our present consciousness—and when we say that contents representing both feeling and intellect continually pass before the mind, what we mean is not that some of our distinguishable contents (*e. g.*, ideas, such as one's "idea of a horse") belong exclusively among the intellectual facts, while other contents (*e. g.*, pains, such as the pangs of chagrin or of a toothache) belong among the facts of feeling. On the contrary, all facts or contents of the inner life are facts of feeling, and all are also facts of intellect. But some are more exclusively valuable from the one point of view and some from the other. Thus I have pass before me the image of a number, say 500, or of a word, say *physiology*. Such mental contents are undoubtedly to be called rather intellectual facts than anything else; for by virtue of such contents I apply my past experience to the interpretation of my present needs. These are what people usually mean by "pure ideas"—cold, unemotional. But a closer inspection shows that one never attends to such an idea unless, at the time, it is "interesting"—*i. e.*, unless, as a fact in consciousness, it has a sort of present value, a colour of feeling about it, which makes it worth holding as it passes. In the worst case, even our relative "indifference" to an idea that we reject from our present notice is itself an aspect of the passing fact which we now feel or estimate. This fact, then, involves some slight element of satisfaction or of dissatisfaction. Thus all those mental contents by means of which we apply past experience to present needs are also contents that have a present value for feeling. On the other hand, however, no feeling, however intense, occurs to an adult mind without being more or less viewed by us in its relation to past experience. It is recognised, or regarded as strange, or is otherwise commented upon as related to one's past. And thus, though sometimes in a very dim way, it is regarded by ourselves as an intellectual fact.

V. THE FEELINGS.

Relation of Feeling to Consciousness.

§ 24. We pass next to the special classes of contents, and first to the feelings. Complex masses of very marked feelings present together are called emotions. The feelings (compare § 13, § 21, and the section immediately preceding the present) are not a separate or separable group of the contents of the mind, but by this word we mean *all* the contents of the "stream of consciousness" *in so far as, at the moment of their passing, they have an immediate value, either in themselves or in view of their relations to other contents.* Thus, again, feeling is another name, of course, for what is often

said to give the passing states their momentary "worth" or to make them "worthless." By virtue of such worth or worthlessness they seem, as they pass, "satisfactory" or "unsatisfactory." Now, some facts of consciousness are "cold," and their colour of worth (the degree of feeling which attends them, and which forms one aspect of them) is small. These colder experiences are usually treated as if they wholly belonged to some other class than the feelings—*e. g.*, to intellect. But, as a fact, these contents, too, have an aspect which gives us a right to class them, precisely in this aspect, with the feelings; for, after all, the whole of consciousness and every part of it has its passing value. Nor can one in any fashion so separate out the feelings from their entanglement with the other aspects of mental life as to treat them as if they could exist alone. The whole stream of consciousness is coloured with interests, or with "what makes life interesting," whether the particular contents be satisfactory or unsatisfactory. Names which denote contents or masses of contents, so far as they are contents of feeling, are such names as joy, grief, anger, unrest, peace, happiness, unhappiness, surprise, misery, contentment, etc.

Pleasure and Pain.

This general character of being momentarily satisfactory or unsatisfactory is itself one which appears in our mental contents in the most varied fashions. Psychologists usually attempt to simplify the matter by calling what makes the passing colour of feeling satisfactory its *pleasurable*, and what makes it unsatisfactory its *painful* tone or quality. In fact, the names *pleasure* and *pain*, suggesting, as they at once do, rather the stronger and simpler experiences that we get in the world of feeling than the fainter and more complex experiences, invite us to reduce our account of our feelings to a relatively simple formula. Pleasures and pains are unquestionably, in at least one aspect of their conscious existence, feelings—*i. e.*, they involve aspects of passing experience such as give it momentary value for us, and such are most obviously marked aspects of many of the passing experiences that we get through our sense-organs. A toothache is a pain. It is also, to be sure, more than merely painful feeling. It has its intellectual aspect, since one recognises it, relates it to past experiences, localises it in the lower or in the upper jaw, and is led by its presence to think of its probable causes. It has its volitional aspect, since it forms an essential part in one's consciousness of the plan or act of trying to get rid of it, say by resolving to visit a dentist. But regarded as mere feeling, this pain is a fact of passing consciousness, whose "colour" or "worth," distinguishable from all its other characters, lies in the fact that it is not only unsatisfactory, but "intolerable." If one failed to recognise or to localise it, if one could get it into no relation to past experience, if one had no plan for getting rid of it, if one could form no resolve about it, still (so one may by abstraction insist) there *would* remain the brute fact of its intolerableness—a

matter of unreflective passing estimate—an intense colouring of the pain as a feeling. A similar analysis would hold for the intenser pleasures, except that they have about them the contrasting colour of immediate satisfactoriness, or "attractiveness," or "acceptableness." The intolerableness of a violent pain, the momentary attractiveness of a keen pleasure, may also be said to be present in consciousness as possessing an *intensity*—*i. e.*, as being greater or less in *amount*. And thus such feelings are apparently *quantities*, and are sometimes spoken of by psychologists as if they were measurable quantities. And from this point of view some have defined, on the basis of such facts, the general maxim of all our prudence as being the rule: "So act as to get the greatest sum of pleasures and the least total amount of pains," thus assuming that we can at least roughly compute and sum up our quantities of pleasure and pain.

If such an analysis is to hold of the simpler cases, why not extend it (so one may say) to the more complex and subtle experiences of feeling? The masses of feeling which constitute what we call "joy" would thus be nothing but groups or streams of pleasures. "Sorrow" would mean a complex of many pains. "Surprise" is either mainly pleasurable in colour or mainly painful, and, according to this view, would be, as a feeling, made up of pleasure and pain more or less mixed, and so sometimes of pleasures almost alone or of pains almost alone. Thus all feeling, as such, would mean the pleasure-pain aspect of the contents of our consciousness, and the whole theory of the feelings would be reduced to the theory of the nature and the varying intensities and combinations of our pleasures and pains. This, then, is a frequent theory as to the feelings.

But it may well be questioned whether such an account is not a merely artificial simplification of the enormously complex facts of the world of feeling. Pleasures and pains, in the typical case, are names especially associated in our minds with the experiences of certain of our senses. A burn or a toothache is a sensory experience, whose disagreeable or unsatisfactory tone is only one aspect of its nature. It has also its intellectually important character, since, as just pointed out, it is usually pretty clearly localised, and is, like any other sensory experience, referred by us to a source outside of ourselves. Now, the clear and unmistakable character of our more decided sensory pains—which are, not only in the just-mentioned respects, facts like the rest of our sensory contents, but also, like our other disagreeable feelings, unsatisfactory—this very definiteness of character, renders these more violent sensory pains poor examples to illustrate the peculiarly subtle and complex facts of feeling in general; for our feelings, while always either intensely, or vaguely, or in a relatively indifferent way satisfactory or unsatisfactory to us, still show many other characters present in them besides those of the sensory pleasures and pains. Consider, for instance, the masses of feeling which make up won-

der, anger, reverence, our intellectual interests in general, or our feelings of the "sense of humour." Common to all these cases is the presence of values—*i. e.*, of objects of combined satisfactions and dissatisfactions. But how hard it is to be content with reducing, in all cases alike, the satisfaction to pleasure, the dissatisfaction to pain! That this can be done is a mere dogma of certain psychologists.

Another consideration enforces this difficulty. In all our waking life an element of dissatisfaction is in so far mingled with our experience as it is true that we are always interested in passing on from any experience to the next. If we have a satisfactory pleasure, we want it to be still more intense, and so are at the same time dissatisfied. If we listen to music, we are always expecting the next note or chord to the very end. If we are attentive, we are looking for more clearness as to the object of our attention. And so consciousness seems to be largely a concern in what shall come next. But this universal inner restlessness of consciousness, variable in degree, but apparently always present, however keen our pleasures—is this mere restlessness itself a pain? Yet it surely involves a certain element of continual dissatisfaction with the present. On the other hand, whatever interests us, and so draws our attention, seems to be an object of which we in such wise want more that, when we get this "more," there is a certain element of relative satisfaction in the attainment. Yet a novel pang of any sort, painful in itself, may be an object of just such interest. So far as we get satisfaction of this interest, we accordingly get, for the time, more of the pain before our clear consciousness than we should otherwise get. Shall one change the formula and say that here the getting of a pain is a satisfaction? An angry man, at all events, often takes a keen satisfaction in dwelling upon thoughts and deeds that are at the moment giving him great pain. Still further, in brooding grief, a mourner, refusing to be comforted, finds what he himself calls a "gloomy satisfaction" in dwelling on his loss. The promise of a cheerful or even highly pleasurable distraction he may then reject, even when he begins actually to feel the coming pleasure, with the keenest dissatisfaction. Very much the same is true of a man "in the sulks." Nervous troubles of many sorts, insistent ideas, forebodings, morbid questionings, and the like, include many cases where nothing so attracts the sufferer as a content of consciousness which meanwhile gives him inner pain. Even the tune that "runs in one's head" often illustrates this sort of thing.

On the whole, then, it may well be affirmed that while there are many pains which are always merely unsatisfactory, and many pleasures which are always attractive, the terms satisfaction and dissatisfaction name a character present in mental states which is of a much wider range than the characters indicated by the words pleasure and pain. We may find

some satisfaction in a pain, some dissatisfaction in a pleasure, and much interest in experiences which have little pleasure or pain about them. Desire and aversion, attractiveness and distastefulness, agreeableness and disagreeableness—these are still other names for aspects or for cases of the facts of feeling. But that pain is commonly disagreeable, that pleasure is commonly attractive—this does not warrant us in saying that dissatisfaction means pain, or that satisfaction means pleasure.

Feeling, then, is the valuation of the contents of consciousness, or the presence of values in consciousness. And value means, primarily, satisfactory or unsatisfactory character. The unsatisfactory, as such, we in the end reject. It arouses devices to get rid of it, and so "spurs on the will." The satisfactory, as such, we rest in and accept. Meanwhile, the two coexist and are interwoven together; and consciousness is never without some element of dissatisfaction, and rather seldom, at least in any fairly normal life, without some element of satisfaction in it.

The physiological basis of the feelings is still, in many regions, extremely obscure. Pleasures and pains of a sensory type are dependent in part upon the degrees of stimulation to which our sense-organs are at any time subjected. Over-intense stimulation of any sense-organ produces pain. The pleasures of sense are all of them the results of relatively moderate stimulations. But there are many sensory nerves that never give any sharply marked and well-localised sensations except painful ones (*e. g.*, the sensory nerves of the viscera, of the teeth, etc.). Altered organic conditions, such as inflammation, also give rise to a high sensibility to pain. Both muscular and nervous fatigue are, again, well-known conditions of painful sensations, although the theory of the process is still obscure. On the other hand, painful sensations may be eliminated by some anæsthetics, or by some diseased nervous conditions, without the disappearance of other forms of sensation (*e. g.*, of touch-sensation) in the parts affected. The painful sensations, when aroused through sensory stimulation, seem to travel in part upon paths through the spinal cord which are different from those travelled by other stimulations, so that pain does not always reach consciousness as soon as do other sensations aroused at the same time, and by the disturbance of the same region on the skin. If one

Physical Relations of the Feelings.

passes to other sorts of feeling, desires and aversions express themselves in characteristic movements (see § 13); and it is probable that the incoming muscular sensations produced by these expressive movements (movements whose causes lie in the hereditary and habitual nervous tendencies of our organisms) form part in our very feeling of the desire or the aversion itself. (Upon this view Prof. Münsterberg has recently laid stress.) Our more complex emotions are also doubtless deeply tinged by masses of other internal sensations more or less indirectly derived from the organs

affected by the expressive movements, and thus much of our conscious feeling is actually secondary to what is called the expression of the feeling. Thus our griefs alter their emotional tone according to the sort of external expression that chances to be forcing itself upon us. Tearless grief is one thing, tearful grief another; and no doubt an important part of the inner attitude of mind which constitutes the grief is determined by our very sensory consciousness of how we are expressing ourselves. This manner of expression is largely determined by our inherited instincts and acquired habits. Reacting to a given environment in a given way, we then feel our own reaction. In telling about the tone of one's own emotions one often has to say, "My heart stood still," or "I felt a choking in my throat," or "I found myself gasping." The poets are accustomed thus to remind us of emotional tones by mentioning their manner of expression, and by so suggesting how this manner of expression itself feels to one who finds himself giving way to it. Thus Bayard Taylor tells how, as the soldiers in the Sebastopol trenches sang "Annie Laurie," "something upon the soldiers' cheeks washed out the stains of powder." This importance of the instinctive or habitual expressive movement as a primary reaction to a given environment—the emotion being the secondary result or feeling of this reaction—has been of late especially insisted upon by Prof. James.

Brain-fatigue.

Meanwhile, however, there can be no doubt that, in addition to all states of our organs of external and of internal bodily sense, purely central nervous conditions have much to do with the tone and intensity of our emotions. Brain-fatigue of all degrees, from the lightest to the gravest, is likely to show itself in altered emotional tones, even where it gives few other easily marked signs of its presence. There are known diseases of the brain (such as the extreme forms of nervous exhaustion known as melancholia and mania) whose principal symptoms are profound alterations of emotional tone. The phenomena of these disorders, as well as other known facts, have been regarded by many as indicating that the current conditions of the blood supply in the brain are direct causes of our emotional states.

Emotions.

§ 25. The practical aspect of the life of the feelings, and in particular of the masses of feeling called the emotions, is of great importance. Whatever their precise physiological explanation may be, we are in any case warranted in saying that in the feelings, and in their expressive signs, we have in general an especially useful *index of the current state of the nervous centres viewed as a whole.* The state of a man's present feelings may indeed, at first sight, throw comparatively little light on his character or on his experience, except where one already knows what opportunities he has had to cultivate or to learn to control just these feelings. It is noto-

riously unfair to judge any man by his momentary mood. The now violently angry man may be, in general, a person of amiable self-control. Especially absurd, as well as uncharitable, is, therefore, the habit of those who regard a character as best to be read by considering the most passionate or otherwise marked emotional excesses, or the weakest or most foolish moods which are known to occur in the life of its possessor. So to judge is to commit what may be called the scandalmonger's fallacy. But, on the other hand, for a good observer, an emotional reaction, regarded with due reference to its external causes, does tend to indicate the passing general nervous state in a way which is of great value for psychological diagnosis. Nervous exhaustion, mental overstrain, show themselves (as just pointed out) first of all in emotional variability. This the popular mind generally recognises. What is not popularly so well recognised is the fact that this emotional variability of overstrain is not by any means always equivalent to the tendency to "black moods" or to ill-temper, but may show itself—and in grave forms, too—in emotions of a relatively cheerful or benign seeming. The sufferer from nervous overstrain may have hours, or even periods, of abnormal vivacity, when his friends, remembering his former fits of gloom, feel that now he is surely restored to himself since he is so ambitious and animated. But the symptomatic value of an emotional state lies rather in the degree of its variation from the normal mean of the individual temperament than in its agreeable or disagreeable seeming.

Emotional Variability.

If emotional variability is often a useful index of nervous overstrain, *the permanent common quality at the basis of any man's normal emotions,* if once made out, *is indeed also an important index as to the fundamental type of his nervous temperament.* By this one does not always mean his *predominant* emotions, which may be made predominant merely by his business or his fortune. One means something deeper. The emotional *undertone,* as one may call it, of any given individual is always one of the most interesting features of his character. It must be made out by observing him in a number of sharply contrasted passing moods, especially when such moods are determined by circumstances rather unfamiliar to him. One then finds it henceforth curiously independent of fortune. The fundamentally cheerful man is thus to be found, even in the midst of the keenest distress, and even when he cries out with his bitterest anguish, still, at heart, not really despairing, but in possession of a certain fundamental sense of satisfaction in living, which no mere fortune can overcome and which only a serious brain disorder can set aside. There are other men, and often very resolute men too, who have withal a deep-seated emotional distrust of life, which never leaves them in the midst of the most joyous

Emotional Undertone.

good luck. They may be enduring, patient, even heroic, but they are never on decidedly good terms with their own inner state. Such undertones of emotion, when one has learned to observe them in any individual, remind one of the temper of an old violin, or of the quality of an individual's voice—facts which remain amid the greatest varieties in the music played or sung. Like the violin's temper and the voice's quality, this emotional undertone is unquestionably the accompaniment of a permanent physical organisation. In case of the emotional undertone this is the inherited temperament of the brain—a fact which, when once thus diagnosed, may be henceforth counted upon with great assurance. The emotional undertone appears to be noticeable in many cases fairly early in childhood, although it is liable to great changes in the course of development, particularly in early youth.

Abnormal Emotions.

Abnormal emotions may occur in a great variety of forms. They appear not only as variations from the normal intensity or steadiness of the otherwise unobjectionable emotions, but as associations of emotions with objects, situations, or habits, with which these emotions ought not to be associated in a healthy organism. Our feelings, as we have seen, accompany certain nervous conditions which colour, and in part determine, our whole "adjustment to our environment." If the feelings are distorted, this indicates a distortion of these nervous conditions, and so this whole adjustment must tend to fail. Conversely, a failure of our adjustment, if determined by nervous conditions which express themselves in signs of feeling, is itself a proof that the feelings are worthy to be called abnormal; for our main test of the "normal" is the power of successful adjustment to one's world. All violent passions in ordinary life are therefore relatively abnormal emotional states. The man who adjusts himself well "keeps his head," whatever the temptations to passing moods of confusion. Just so, however, morbid fondnesses for dangerous objects or deeds (*e. g.*, a craving for intoxicants or a love for unwholesome reading) demonstrate their unhealthfulness by the very fact that their results are instances of moral or of physical failure to adjust one's self to one's environment. But the morbid emotion need not be either a violent or a special experience. The whole emotional undertone of any "perverse" character is, in its own degree, an abnormity; and such an abnormity may calmly outlast years of training and thousands of broken and spasmodic resolutions. In fact, what is called "perversity" of character generally *means* simply an abnormity of the emotional undertone, and is as hard to alter as the latter.

Yet, of course, great and enduring emotional abnormities can be the result, not of heredity, but of training. Some of our emotions (*e. g.*, our cheerful or gloomy undertone) are principally due to heredity; but others are very much moulded as they develop in our early lives. Hence the

importance of care as to guarding the growth of such sorts of emotion as are subject to the greatest degree of development during childhood and youth.

A striking and critical instance is here the whole world of the sexual emotions, including the romantic and the "sentimental" tendencies. These, normally absent or only sporadically hinted at in the emotional life of childhood, develop with great rapidity at puberty and for some years afterwards. They normally occur at first as the phenomena of reaction to particular series of facts in the environment, and they occur both with and apart from more definite acts. But they also normally tend to spread through and colour gently one's whole life to its very highest and noblest levels. Religious emotion, for instance, has deep relations to them. It is the business of parents, teachers, and other guardians of youth, to see to it that these more subtle emotional reactions are controlled by duly controlling both this environment and the youth's sentimental and passionate relations thereto. The laws of brain habit determine the principle that when experiences are keen and novel, any reaction then accomplished determines the brain's whole future to a degree never later equalled by other actions of the same sort and number. Does one early form an association between certain objects and certain vigorous emotional responses, one's emotions are thenceforth given what may prove a permanent "set." This, as recent investigations have more and more shown, is peculiarly the case with the sexually emotional reactions. Whether a youth is to be a libertine at heart or not, and whether or no his sexual imagination and feeling are to be definitively perverted even while they grow (perverted in fashions that are sometimes horribly grotesque and mischievous), is often determined by the earliest stages of his sexual experience, wherein must be psychologically included most of his youthfully sentimental experience, together with even his religious emotions. However convention, or resolution, or morality may later teach him to control his more definite or more external acts, the "set" of his inner sexual consciousness, and of all that more or less unconsciously gets built up thereupon, the purity or impurity of his feeling as a whole, his capacity for honourable love, the whole colouring of even his highest social emotions, his love of honour, his truthfulness, his humanity of sentiment, may be established for life by the emotional responses that he makes to a comparatively few situations in his early world of ignorant youthful sexuality—a world to him uncomprehended, and one where too often, alas, he is wholly unguided. It is one of the saddest of psychological blunders that even wiser guides often leave the young to fight this confusing battle of these inner emotional states alone, and so such guardians, entrusting the young to the mere chances of foolish companionships, subject some of the most delicate and momentous emotional functions of the youthful brain to a treatment that

no man of sense would give to his watch, or even to his boots. To be sure, a false light, a deceitful guidance, an ignorant sort of terror at possible mishaps, would in these matters itself determine or even constitute a perversion. Guidance does not mean mere random meddling. And even a cheerful indifference accomplishes far more than a morbid anxiety. But one need not ask for a false artificiality of instruction, only for a cool and reasonable "symptomatic guidance" of the young, given confidentially and treated as a matter of course, by watchful guardians; given, moreover, just when the charge is seen actually to need it. There is, meanwhile, no one routine of instruction as to such matters. Each case ought to be watched for itself.

The mention of abnormal emotions leads to the practical problem of estimating their significance when once they are present. Regarding the phenomena of any given morbid emotional state, whether permanent or transient, it is a general rule that, of two morbidly emotional moods or individuals, viewed in general, and apart from special causes: the cheerfully morbid is likely to prove worse than the painfully morbid. False despair, within limits, is, psychologically speaking, much more benign than false confidence or than vainglory. One sees classic instances of this in the case of the before-mentioned fundamentally "perverse" characters. Such persons, in case their abnormal emotional "undertone" is one of dissatisfaction (of gloom, or self-distrust, of morbid conscientiousness), may be indeed, in the strict sense, incurable, since one cannot provide them with a new heredity. But they can often learn, within their limits, how to get a very effective sort of self-control, and to live tolerable or even nobly useful lives, simply because they suffer for their frailties, and consequently strive for some sort of salvation. But the cheerfully perverse, whose undertone is often one of vainglory, and who accordingly revel in their own perversities, are much more hopeless cases. You may give them the clearest sort of knowledge, and they may have a high order of intelligence with which to grasp it, to restate it in their own words, and even to preach it; yet at heart they understand their own perversity only in secret, or openly, to admire it. The sole hope lies in getting them where they keenly suffer, not, to be sure, any external or arbitrary penalty, but what they can come to view as the natural result of their own characters. Even then, however, it is a ceaseless marvel to the onlooker how much they can suffer without either losing their false optimism or essentially mending their evil ways. They may change numerous special habits of conduct, but they still cling to the central enemies of their life. Self-induced anguish is often their only possible medicine, yet they tolerate it in simply enormous doses, and often go on as before to their doom, persisting that they have learned wisdom, but daily manifesting that they are fools.

A similar rule holds, as said above, regarding the judgment of even passing moods. A state of nervous fatigue which is extremely disagreeable is in general nearer to the normal than a condition in which we are actually very tired, but feel extraordinarily vivacious. Cheerful insomnia is far worse than even a decidedly painful sense of weariness when accompanied by sleepiness. Even anger that is uncontrollably violent, and that causes the keenest suffering to the angry individual, is less abnormal than that lucid type of fury which its possessor fairly enjoys and nurses. Temper of the first sort quickly wears itself out in pathetically helpless reactions. Temper of the cheerily malicious sort may make its possessor a criminal before it lets go its hold. After great calamities people are often "dazed" into an ominous insensitiveness. The return to the normal is then marked by an anguish which the sufferer himself welcomes as a sign that he is again "coming to his senses." Thus in general good observers are not easily appalled by the mere appearance of suffering. Mental anguish, viewed as a psychological phenomenon, and apart from any otherwise known and serious external cause for sorrow, is always an abnormal incident; but it is frequently, in its consequences benign, in its direct indications relatively insignificant.

VI. THE INTELLECT, OR THE ORGANISATION OF EXPERIENCE.

§ 26. All the contents of the stream of consciousness, *in so far as they constitute experience—i. e., in so far as we learn from them*—are contents of Intellect. When we viewed these contents as feelings we found in them, everywhere present, a certain colour of passing estimate, an immediate sense that they were worth something to us at any given moment, or that they then had an interest to us. When we view these same contents in another light we observe that not merely their passing interest, as such, has a real importance for us, but that this momentary value, as we feel it, is but a hint, and sometimes a poor one, of the real place that they have in relation to our adjustment to our environment. Not only that given states now pass, *but that certain former states have been*, guides us in our dealing with the world. *In so far as we either recognise or otherwise profit by this relation between our present and our former states, or in so far as, by virtue of such a relation to the past states, we are led to expect any future state, our mental states are said to be experiences, and they then have, in addition to their direct value as feelings, an indirect value as indications of truth, as sources of knowledge, or, once more, as intellectual conditions.* This "indirect value" we shall henceforth call their "intellectual value."

The life of the intellect is far too rich a field to be even fairly sketched in this study. What here follows is limited by the purely practical aim before us.

Our past experiences are now of use to us in our adjustment to our environment, because they were associated with nervous changes which tended to mould our conduct into conformity with external physical facts, and which have established certain more or less fixed habits of brain. Our present experiences, as such, now serve to guide us, in so far as their physical accompaniments appeal to these established brain habits; or again, in so far as these new experiences tend to modify the old habits. *The power to learn by experience is founded upon the power of the brain to acquire and to retain habits.* (Cf. § 16.) At any moment a disorder of brain which suspends or destroys the nervous conditions of habit impairs in the same degree the intellectual powers. These considerations are fundamental in the whole theory of the psychology of the intellect.

Past and Present Experiences.

On the other hand, by no means the whole of our experiences are of equal value for our process of learning by experience, or for arousing us to make use, at any moment, of what we have formerly learned. Many inner facts are of great passing importance for feeling, which are of little intellectual concern. One eats three meals daily and should enjoy them heartily; but since one has come to mature years one has learned comparatively little by such experiences, unless one is a housekeeper, a gourmand, or a cook. But one may have seen but once a given landscape, or scientific experiment, or man, and may have learned a life's lesson from that experience. An experience is intellectually valuable in proportion as it either moulds our habits or calls them into action. It is sometimes said that the value in feeling of a given experience is universally in inverse proportion to its intellectual value. This, as thus universally stated, is not true. Dante's first boyish meeting with Beatrice moulded his whole intellectual life, but was full of the deepest feeling at the moment of the meeting. But one can indeed say that the value in feeling of a given experience bears no sort of constant relation to its intellectual value. A burn is an intellectual experience, when it teaches a child to dread the fire. But so is a light touch, say of a new fabric, if it teaches a blind man to recognise henceforth that fabric. In general, violent internal bodily pains (*e. g.*, the colic or a headache) have comparatively little intellectual value, because we too seldom rightly associate them with their causes, so as to learn easily how to avoid them in future. Moreover, they last longer than they are needed for purposes of warning, and our memory for their intensity is poor. On the other hand, very gentle experiences, say the memories of past scenes, reproduced in the form of very faint images, are, in all persons, of great intellectual importance, as being connected with old habits of action. Pains of the external sensory organs (burns, bruises, dazzling lights, etc.) play a great part in our earliest intellectual education, but are normally of far less moment

later unless we learn some new art (*e. g.*, bicycling, or handling electric apparatus).

So far for the vaguer variations in intellectual values. But now for more precise rules. These are:

1. An experience is of intellectual value in proportion as, through the laws of habit, it becomes linked with other experiences. *No experience is of any intellectual importance in so far as it stands alone.* Its nervous accompaniments in the central nervous system must be functionally linked to processes that have been the accompaniments of former experiences if it is to prove effective for intellectual purposes. This usually happens as follows: Let a new experience, *a*, resemble, in some definite fashion, a former one, A. Then its nervous accompaniment will also resemble and nearly reproduce functional processes formerly present in the cortex. The law of habit runs that an old function, when once reproduced, tends to induce those other processes which it induced, or with which it was linked when it was before present in the brain (§ 16). The new experience, *a*, resembling the former one, A, will therefore be accompanied by a process—viz., the reproduced A-process, that tends to pass over into certain other definite and localised processes. These other processes will somewhat correspond, however, in general to still other former experiences which of old actually accompanied or immediately followed A, since the A-process of old passed over into these other processes. Let these other former experiences, as they originally were, be B, C, D. Then *a* will now tend to be followed by experiences *b*, *c*, *d*, which more or less resemble the former B, C, D, respectively. *In this case* a *is said to be linked by association with these other experiences*—viz., *b*, *c*, *d*. For here the result of *a* is a tendency (which may or may not at any one time prove effective) to the appearance in our minds of experiences *b*, *c*, *d*, more or less resembling what those other experiences (B, C, D) originally were. So, when I see an apple-tree in winter, I may be reminded of the apples that were growing there last summer. That is, the present experience of the tree is accompanied by central nervous processes in the cortex which (by habit) tend to induce some of those nervous functions that were induced last summer when I saw the tree in full leaf with the apples growing. The latter functions can never be wholly reinduced, but the result is a state which includes something resembling, at least, a portion of them. *This association of our experiences in groups is the primary condition of their getting any intellectual importance.* And here we meet with the psychological expression of the fact above observed, that intelligence especially shows itself in the adaptation of old habits to new needs.

Association.

2. The "background" of consciousness at any moment (see § 22) is always of relatively small direct intellectual value for that moment,

although, in case it supports the general "set" of our attention, it has an indirect value; and in case it long retains any definable character, this character may slowly acquire an importance through its relation to our habitual brain functions. Those states which stand out (or "float") with a marked relief above or upon the general stream of consciousness are of relatively great intellectual importance. Or, in other words, *experiences are of intellectual importance in proportion to the marked or definite character which they have in relation to the experiences that accompany them.* Definite conscious experiences stand for markedly predominant functions of the cortex at the moment in question. The more sharply localised the function in the brain, the more definite is the brain habit which tends to be formed. This principle lies at the basis of all effective *attention.*

Attention.

3. In order that our states, viewed as a whole, should become at any moment definite, and therefore intellectually valuable experiences, *they must possess, in a certain degree, marked differences from the sum total of the states which have immediately preceded them.* It is this "shock of difference" which accompanies the whole play of consciousness and makes every intellectual process possible. Even when we long attend to one object, we are busily "changing our minds" about it—questioning, conjecturing, observing various aspects, making use of different habits, trying various assertions. To have "one idea" is to have no idea at all. Discrimination is thus an essential function of intellect.

Discrimination.

4. But discrimination itself never stands alone. A mental state, in order to be of relatively immediate intellectual importance, must not only stand out in consciousness as against its background, and must not only differ from what has preceded, but must further, as we have seen, stand in connection with similar past experiences, since otherwise it appeals to no habits of brain. These similar past experiences, when "represented" at any moment, *resemble* the present mental state. And they join with whatever else in present consciousness resembles this new state, *to help us to assimilate it.* To know is to note not only difference, but also resemblance; not only contrast and variety, but identity and harmony. An utterly strange state is of small intellteeual value. And so, in addition to its associative connections, an intellectually important state *must have relations of resemblance to its context in our consciousness.* Knowing is thus discrimination plus identification. This is still another expression of the principle that intelligence means adaptation of familiar facts to novel needs.

Identification.

§ 27. The classes of intellectual states are numerous. First in order, and in importance as regards the original genesis of the intellectual life, are the sensations. These are our momentary experiences, in so far as

they correspond to the excitations of the organs of sense. They therefore accompany the incoming stream of sensory disturbances of §§ 15 and 16, above. No exhaustive and perfectly satisfactory classification of our sensations is yet possible. The popular division according to the "five senses" is certainly inadequate. From our internal bodily organs we receive many masses of ill-defined sensations of the "common sensibility." What is often confused together under the name of "the sense of touch" involves numerous strongly contrasted experiences. Simple pressure, heat, cold, muscular sensation proper, joint-sensations—all these need, for psychological purposes, to be discriminated in what has sometimes been viewed as "touch," while the pains of touch-sensation have already been mentioned. In addition to the foregoing, one must mention sensations which have a special organ in the semicircular canals of the inner ear, and which are aroused by the mere fact of the movement in space of the head or of the whole body. The feelings of "dizziness" often accompany an extreme form of these sensations. Then come the popularly well-recognised sensations of smell, taste, hearing, and sight. But even here, in the sense of sight, some psychologists have been disposed to distinguish the sensations of movement in the field of vision from the others, just as a similar division has been proposed in case of the sense of touch itself.

Sensations.

We must leave, however, to special treatises the discussion of the classes of sensation. Our interest lies in the general value of the sensations as experiences. This value depends upon the fact that the nervous accompaniments of sensation—viz., the incoming streams of sensory impressions—are the causes which excite and support that whole series of interchanges of induced activities upon which the motor functions of the brain depend, and by virtue of which our brain habits are formed. *Without series of definite sensory experiences no habits of brain or of mind:* this is the great principle of the *source of our experience.* On the other hand, in any given "set" of brain (cf. §§ 16, 17), those already-formed brain habits are excited to which the incoming sensations favoured by that "set" then and there appeal. As they are excited, the habits tend to become, in their turn, modified by the new sorts of sensory disturbance which awaken them. In early experience this alteration is often very decided. Later it tends to become often inappreciable. The principle of association (§ 26) determines the result that sensations directly tend to arouse those habits which were formed in the past by the action of sensory disturbances similar to the present ones, in so far as the current inhibitory "set" of the brain does not interfere to prevent this result (§ 17). And the rule thus holds: *Without present sensory support, no use of old brain habits*—a rule which governs the whole *current employment of our experience.* As a fact, even in the most absorbed meditation, we are constantly sup-

ported by masses of fitting external (or internal bodily) sensations. One thinks best on a given subject while reading certain books, sitting in a given study, listening to a given speaker, holding a pen and writing, or while getting whatever other experiences habit has made effective.

§ 28. Of the enormously complex processes which follow upon sensation we can give only a hint. Our sensations never stand alone in the maturer mind. They are effective only in so far as their nervous accompaniments awaken habits. But, as a fact, the habits of the brain have at all times been moulded by great masses of sensory disturbances acting together. The results of current sensation are then, in general, mental experiences which more or less resemble past experiences belonging at once to many senses. The brain habits accordingly tend to *a complex restoration of former conditions.* What we see reminds us not only of former sights, but of former touches. The colour of an orange suggests its odour and taste. The sound of a word may recall the appearance of the word as written or printed. Now, these recalled experiences, usually rather faint unless we dwell upon them, first tend, by reason of their swiftness and faintness, to coalesce with the present experience, which then stands before us as a whole mental state, a group of interpreted sensations—a perception. A perception, then, is a group of present sensory experiences interpreted in terms of our past experience of those outer objects which were similar to the one that has aroused this group of sensations in us. The nervous process accompanying the perception depends wholly upon our brain habits. The brain tends to do again what it has done before. Just so, in our accompanying mental life, we tend to recognise in the new what we have already experienced in the old. Such habits of recognition may often lead us astray —as when we fail to note typographical errors, or fall prey to optical illusions.

Perceptions.

Upon a similar process, however, all our higher intellectual life depends. Our memories are determined by associative functions. What has been connected in experience tends to be connected in idea. The series of remembered experiences, again, runs parallel to the reawakening of already-established brain-habits. Our trains of inner imagination, even in the case where we seem to ourselves most fantastic, are themselves the accompaniment of reawakened brain functions whose results, instead of coalescing with our sensations (as was the case with our perceptions), stand apart, so that we often fail to note the ever-present support which our current sensations, derived from the organs of external sense or from our internal bodily organs, give to even our freest imaginative processes. Yet one has only to note how the imagination of a dyspeptic, or of a sufferer from headache, or of a person listening to an organ played in church, or watching moon-

Memory and Imagination.

light sparkle on water, varies with the current sensations, to see how imagination also involves brain-habits determined by current sensory impressions.

Thoughts.

Our organised relation to past experience is still more obvious in our thoughts, which are everywhere interpretations of sensations, of images, or of masses of other ideal contents, by virtue of their relation to our former experience.

§ 29. These higher modes of intellectual life—Perception, Imagination, Memory, Thought—require, however, another set of considerations to make even their general character at all intelligible.

Motor Tendencies.

Our sensations, we have said, support our intellectual processes by awakening brain-habits. But the brain is an organ that directs movements, and the habits of the brain get their effective expression either in actual movements or in motor processes which, although inhibited, are none the less present as tendencies. Now we actually have states of mind which correspond to such motor tendencies, even when these are existent in an almost wholly inhibited form, and merely as tendencies. *Our perceptions as well as our higher intellectual process are in large part made up of mental material which corresponds to more or less completely suppressed movements—movements which we image, in abbreviated forms, even when we do not make them, or movements whose results we image even when we do not carry them out.* The motor aspect of the intellectual life constitutes one of its most significant features. *Thought is the correlate of present but suppressed muscular tendencies.* These tendencies, aroused by sensory impressions, woven into series by our past habits, adjusted to our present situation in the most delicate fashions, by virtue of the similarity existent between present and past experience, altered also by our present discriminations, and inhibited, or at least reduced to very faint motor tendencies, by the present "set" of the brain—these constitute the physical accompaniment of our most abstract thinking, as well as of our perceptions, of our trains of imagination, and of our memories.

For example, I hear a sudden sound. My perception of the direction whence the sound comes is identical with my consciousness that, in order to hear the sound better, I must turn my head to the right or to the left. This consciousness accompanies an actual motor tendency (the result of long-established brain-habits) to turn my head thus. To judge direction is here to recognise that this noise *means* this useful movement of adjustment in so far as the sound will be better heard thereby. Even so, to perceive in the field of vision that a given object is to the right or to the left, and so or so far away, is to have certain motor tendencies of the eyes, of the grasping hands, or of the general locomotor organs of the body, appealed to and more or less visibly aroused. To perceive where an

object is, is to remember how to reach the place where the object appears to be; and this memory of "how to reach" is itself the idea corresponding to the actual tendency to move thus. *Unless such movements are inhibited they actually get carried out.* One watching an object intently may visibly begin to move towards it; for every idea of any movement, or of the known result of any movement, tends, in proportion to its clearness, to be accompanied by that movement. This principle is the one constantly used in the parlour game of "willing," or by public exhibitors of "mind reading." What is usually "read" in such cases is the motor expression which a person absorbed in watching, or in otherwise imaging an object, inevitably and involuntarily gives to his tendencies to approach, or otherwise to adjust himself to the object, as he perceives or images its place, or its other tangible characters.

Abstracter thoughts, however, have in a similar way their still less visible, but none the less real, motor accompaniments. Much of our thinking runs parallel to an "internal speech" whose expression is an actual series of motor adjustments of the vocal organs. Unless one inhibits these, one "thinks aloud." Deaf-mutes may sometimes be seen "thinking with their hands." Our "general ideas," or "abstract ideas," or "conceptions," of even the highest grade, while they partly consist of a wholly sensuous imagery (mental "pictures," etc.), are acquired in the first place in connection with definite (on higher grades uniformly imitative) motor processes. These processes we usually first repeat after our teachers. Thus one learns what a circle or a straight line is by learning how to make one according to a definite rule. One learns what *ten* means by counting one's fingers, etc. All these processes were originally actual series of movements, which had to become habitual before the ideas in question were at all familiar. Thereafter, at pleasure, we can represent to ourselves the ideas by repeating the corresponding movements. The definiteness of the idea precisely corresponds to the definiteness of the habitual motor process. Where we do not actually repeat such movements while we think, we nevertheless hold and comprehend the ideas by beginning the familiar movement and *then* inhibiting it, or by "feeling as if we could" repeat the movement if we chose—a feeling which corresponds to a mere tendency to begin the movement in question. Where we symbolise ideas by other ideas, as the number *ten* by the word *ten*, we may then wholly substitute for the original motor tendency, whose correspondent was our abstract idea, a motor tendency to speak the word that is said to "express" this idea. And thus, by continual substitutions and resubstitutions of simpler motor processes for more complex ones, we may come to survey, as it were, years of carefully acquired motor habits by means of a momentary impulse to utter a single sound or to make a single gesture. But in no clear thinking is the motor element really

absent. Nobody can think without knowing how to do. The real expression of a thought is an imitative motor process intended to repeat or to reconstruct what we have perceived. All true thought has thus its practical tendency. There is no such thing as the "pure intellect" out of relation to activity. One understands what one can reconstruct or imitate; and one learns by accomplishing—a fact which is of the first importance for all teachers of the young. The more abstract the ideas are which one is to teach or to learn, the greater the need for constructive motor processes to accompany the work of the learner. Nobody gets ideas without responding to one's environment, and our mental images, however rich, are of no intellectual importance except where they are linked to definite brain-habits, which somewhere run out in action. The one distinguishing feature of the motor processes which express our thoughts is that they are all *explicitly imitative movements*, although the imitations are often highly symbolic.

Judgment.

There is here only time to say further: (1) That, among the processes of the higher intellectual life, what is called the activity of judgment (as logicians use the term) is, in general, the mental aspect of an effort to imitate the structure and relations of things by means of combinations of words. In judging we try to combine our words as, in reality, the objects or characters named by the words are combined. And thus our judging is as much the mental accompaniment of an imitative motor process as is the activity of drawing pictures. A judgment that satisfies our own ideals as to how judgments should be made is accompanied by a familiar feeling called Belief. Belief, then, is a feeling of satisfaction in our own activity of judgment. (2) That what is called reasoning is, in general, a process which involves judging (*i. e.*, again, imitating in a new act) the result which has followed from some exact constructive process which we ourselves have just accomplished. Consequently, what judgment is to its objects—viz., an imitation of them by means of an order which we give to our words—such is our reasoning process to the results which have followed from our processes of judging. To reason is usually to judge about the outcome of former judgments. And so reasoning also runs parallel to motor processes of an imitative, although highly complex and symbolic, type.

Belief and Reasoning.

Thus the mind of a man engaged in abstract intellectual activity is no exception to the rule that the intellect shows itself, more or less overtly, in the adaptation of our movements to our situation, upon the basis of our experiences. Whoever thinks, moves, or tends to move. And intelligence on the highest as upon lower levels shows itself in the power to adapt former habits to the present situation, old rules to new cases, and new deeds to established modes of conduct.

§ 30. It remains to speak of the process by which our momentary mental states get the clearness or the "relief" upon which (§ 26) their intellectual value so largely depends. As we learned (also in § 26), in so far as we profit by the relation between our present and our former states, our mental states are said to be experiences. On the other hand, in so far as we are directly satisfied or dissatisfied with our passing mental states (§ 24), they are contents of feeling. But now, as it happens, we often find present in ourselves feelings of satisfaction and dissatisfaction in the very fact that given present states have some sort of relation to former states (*e. g.*, are novel or familiar, are puzzling or comprehensible, have obvious relation to our past habits, or need new adjustments, etc.). But thus our experiences come to have a new and important relation to our feelings. An experience has (§ 26) its "intellectual value," over and above the value for passing feeling of what, as a momentary mental state, it contains (as, for example, pleasure or pain). But now, as a fact, *we are able to have feelings which once more express an immediate, a passing, and, of course, often a mistaken, estimate of this intellectual value itself.* Such feelings are called our current "feelings of interest." They have a curious and invariable character, which often brings them into sharp conflict with our other feelings of the same moment. A pain or an agonisingly perplexing problem, although we hate it keenly, may interest us intensely, because we want to dwell upon it until we have understood its cause or nature. When such interests are those of predominant satisfaction they lead us to dwell on the experience for its own sake, as a familiar or comprehended fact. Thus a young child may love to have its known stories told over and over, or to find picture after picture of familiar objects (*e. g.*, men), and to say triumphantly "Man," "Man," on viewing each picture. Here the mere familiarity of the experience is itself what satisfies. But even if the predominant interest in the experience is one of dissatisfaction (as when one is pained or puzzled), still, the only way to satisfy the current intellectual interest in the pain or puzzle (*i. e.*, to reduce the dissatisfaction) is again to dwell on the experience until its relation to the past has been altered (*e. g.*, until it has become familiar or has been "made out"). So it is peculiar to the feelings of interest, or to the "intellectual feelings," that, whether they are cases of satisfaction or of dissatisfaction, the only way to hold the satisfaction or to diminish the dissatisfaction is, in any case, to dwell for the time on the experience as an experience. For, as we have here defined our term, the interest is not a feeling of satisfaction or of dissatisfaction with what the mental state in itself alone chances to contain (*e. g.*, with its pleasurable or painful tone as such), but with its relation to other states or to one's habits. Hence in states of intellectual interest one questions, analyses, compares—does whatever tends to relate

Feelings of Interest.

this object to other objects. One is seeking to know "what to do with it," or is rejoicing in the fact that one does know what to do with it.

Attention.

Now, *attention is the process of undertaking to satisfy such an intellectual interest by dwelling on its object*, or, in other words, *attention is the process of furthering our current interest in an experience when viewed just as an experience.* When I attend to a thing I either try to recognise or to understand it, or I take contentment in an already existent recognition or understanding of it, and dwell upon it accordingly.

If our attention succeeds in any case—*i. e.*, if our passing feeling of current interest is furthered—the object of this interest *grows clearer in our minds;* that is, it grows more definite and gets a better "relief" upon its background. This is the one sure result of the furthering of the temporary and passing intellectual interest, as this interest has here been defined. What we attend to may, as a mental state, be faint in content, but as an experience it grows important. It is discriminated better from whatever goes along with it, is more effective in arousing associations, is recognised more readily, if already somewhat familiar, and tends to be more effective in modifying our already existent habits. Attention involves, of course, by definition, feelings. But these feelings from their nature have, even as feelings, their intellectual value. And attention is the *conditio sine qua non* of all important intellectual processes.

The less artificial and adventitious are our passing interests, the easier and more effective is their satisfaction. Accordingly, it is difficult to attend long to anything merely because we abstractly think that we ought to attend. We must have our interest pretty spontaneously, or we can never hope to satisfy it. What already pleases us for itself is therefore, in general, the more readily attended to in regard to its interest as an experience. The relatively familiar is also more closely attended to than the incomprehensibly strange, unless the latter, by its painful or its portentous aspect, or by its sensuous or other direct charm, arouses our longing to comprehend its significance. Children often wholly neglect whatever is not yet comprehensible to them in their lessons, although some uncomprehended things, such as fairyland, or the doings of their elders, may arouse their keen interest by appealing to their love of beauty, or by awakening their imitative instincts. Interest in objects because of their familiarity or their comprehensibility has been called "derived" interest, and its furthering "derived attention"; but, as a fact, all current interests are, as already shown, more or less secondary feelings.

The physiological accompaniments of attention seem to be of three sorts: (1) Adjustments, of a motor type, whereby our sense-organs are brought into better relations with the object of our interest, or are brought into positions that habit has associated with clear attention, while our

organisms are also rendered otherwise more impressible. Certain characteristic attitudes, gestures, and alterations of breathing and of circulation belong in this category. (2) The assumption of a "set" of brain that tends especially to favour those habits which are of most use in comprehending objects of the kind wherein we are interested. The control which attention displays over our trains of association belongs in this category. (3) In close connection with (2), the assumption of a "set" of brain which tends to inhibit all movements and habits such as would interfere with the satisfaction of the ruling interest. Hence the stillness, the "absorption" of the attentive person. Attention is always a highly inhibitory function. Hence its fluctuating character in children and in many of our states of weakness.

The Intellectual Life.

§ 31. The practical study and proper guidance of the intellectual life constitutes one of the principal problems of civilisation. All efforts to deal with the problem must set out from the fact that the intellectual life is precisely the "Organisation of Experience," and that, on the other hand, both the expression and the very existence of the intellect are dependent upon the formation of rational habits of conduct, useful motor adjustments.

The first principle is itself twofold. It means that the intellectual life depends, as to its genesis in each of us, upon experience, and that, apart from experience, we have no sound intellectual guidance. It also means that no experience is of importance unless it is organised, and that chaotic or irrationally ordered experience is useless, and may be worse than useless. The second principle shows, in general terms, how experience is organised. It is organised by teaching certain fitting habits of conduct (imitative processes, constructive activities, language functions, habits of attentive observation), such as are at once constant, familiar, and accurate as to their general types, and at the same time plastic, adaptable, and controllable, with reference to the novel circumstances that may arise. That this complex object may be attained in case of healthy brains is itself a matter of experience. How to attain it belongs to the art of the teacher—an art whose rules, so far as they can be stated abstractly at all, must be founded on the laws of habit, of interest, and of inhibition—all of them laws which can best be stated in terms of the physical functions of the brain. At all events, he teaches in vain who does not in some way organise the activities, the intellectually expressive deeds of his pupils. Thought is either action or nothing.

The abnormities of the intellectual life are more manifold and sharply definable than are those of the emotional life. The common formula for them all is a failure of due imitative adjustment to the environment, conditioned either by defective sense-organs or by defective or by hindered intellectual habits of brain. This failure, whether its cause lies in hered-

itary temperament, or in early training, or in acute or in chronic disease, is very generally a matter that shows itself more or less plainly to every closer observer. The intellectually abnormal person seems "queer," or is called a "fool" or a "crank," or makes a "failure of life," or, in cases of acute acquired malady, "becomes stupid," or "loses his memory," or otherwise "breaks down." Such things, in a general way, one constantly hears. Intellectual defects and disorders, if considerable, do not easily escape notice, because the keen struggle for existence sets every man busily adjusting himself to his environment, and a serious failure of the brain to display useful habitual functions is sooner or later pretty unsparingly exposed.

On the other hand, the diagnosis of what is the actual failure present in any individual case is much more difficult. There is, one must remember, no such thing as "foolishness" in general, unless, as in case of the extreme idiot or of the patient suffering from advanced *dementia*, one means thereby simple absence of all significant cortex functions. Otherwise, what gets called "foolishness" or "crankiness" is some particular group of defects; and then the question is, each time, what group? It is regarding this question that careless judgment, in general, hopelessly errs.

Here it must be noted, in the first place, that many intellectual defects and disorders are but secondary phenomena, due to disorders whose primary manifestation lies rather in the realm of the feelings. The grief-stricken, the anxious, the worried, the exhausted man, or the victim of violent physical pain, may have, for a longer or shorter period, an almost complete suspension, or else an extensive degradation, of all the higher intellectual functions. This sort of thing, in case of sufferers from acute nervous exhaustion, may assume an outwardly very formidable aspect, and may give the sufferer and his friends numerous fears of impending insanity, even where the whole trouble is of relatively very superficial character. The nervously exhausted are likely not only to be, for the time, intellectually inefficient, but to be keenly aware of the fact, so that their fears of disorder may often tend to aggravate what disorder they have. It is important, therefore, to distinguish the false fire from the real mental danger in these regions.

Nervous Exhaustion.

In cases of simple nervous exhaustion the attention is usually one of the most easily affected intellectual functions. It grows unequal—spasmodically intense as to some matters, uncontrollably helpless as to others. A sense of confusion overtakes one in the midst of business complications or of other intellectual tasks. One's favourite mental work grows unaccountably distasteful, or else morbidly engrossing in its portentousness, so that one cannot lay it aside during the hours of rest. One for-

gets in the middle of a sentence what one was going to say, and is terrified accordingly. One then talks of entire mental collapse. Memory may become more or less unequal or helplessly uncontrollable before the case has progressed far. A complaint of the "total loss of memory"—a complaint, to be sure, often absurdly unfounded—is very common with nervously exhausted patients. Over all these things, however, "the sense of inefficiency," a collection of feelings, may easily be seen to preside if one observes more closely. And a noteworthy characteristic of this whole state is that the nervously exhausted man can actually do all, or nearly all, that he declares himself unable to do, can perform nearly all the brain functions that he regards as impaired, can speak coherently, can avoid confusion, can attend closely, can remember very fairly, if only, without his express expectation, you engage him in a conversation that gets him for the time "out of his ruts," and that so temporarily frees his essentially intact brain from the emotional cloud that is hindering his habits from their natural expression. This is, of course, an objective proof that the clouded functions are not yet destroyed. So that the question of mental diagnosis is here not what the nervous patient can *not* do (when he is left to his anxiety or confusion), but what he still can do when for the time you get his thoughts "out of himself."

This may serve as a suggestion of the nature of a secondary impairment of otherwise intact intellectual processes. But we must proceed to exemplify the intellectual disorders proper. A striking example of disorders directly intellectual in type is furnished by the morbid phenomena, of a sensory character, called "Hallucinations," or false perceptions, which have no foundation in external facts. These occur normally in our dreams, often also on the borderland of sleep, and in a great variety of mental disorders. Sporadically, as single brief waking experiences, they occur also in the lives of healthy people. But they are never present in any considerable number or persistence in a wide-awake person without a decidedly serious nervous cause. This may be a cause seated in part in the external sense-organs, but it generally involves those portions of the brain where the sensory nerves of the sense affected have their central stations. An hallucination is, in any case, *prima facie* evidence of an abnormal form of central excitement. Yet hallucinations, as morbid phenomena, may occasionally exist for a good while in a comparatively isolated form in the mind. The patient may then be quite cool about them, may reason correctly that they are only hallucinations, and may be in all other intellectual respects apparently unimpaired. But this clearness can seldom thus last long. The strangeness of the hallucinatory experience fixes attention upon it. The physical cause of the trouble is usually pretty general. In the further development of the case either a general delirium follows, or the intel-

Hallucinations.

lectual habits, if they remain relatively intact, are gradually but profoundly modified by these sensory intruders. The delirium of fevers and of a number of other nervous conditions of toxic origin is largely characterised by the presence of manifold and massive hallucinations along with great emotional disturbances.

The hallucination, in itself alone considered, is a fair example of a special disorder of the intellectual life. But another form of intellectual impairment appears in what are technically called delusions.

Delusions.

Delusions are morbid derangements of one's habits of judgment. These may be, like sporadic hallucinations, phenomena confined to a decidedly limited region of the intellectual life. But this seems to be seldom the case. If a man suffers from one delusion he commonly falls a prey to more than one, although then his delusions may still relate, for the most part, to some one class of topics. Yet the psychological mechanism is such that delusions, from their nature, tend to influence all of the sufferer's intellectual habits, and nobody can be trusted to remain long "insane on one topic only." One can never tell when the false habit may not show itself in some unexpected region.

While the phenomena of insanity proper belong elsewhere, this sketch mentions delusions simply because of the practically interesting psychological problems of diagnosis which they suggest. As to the name, the psychological usage differs somewhat from the popular usage. The latter often confounds hallucinations with delusions. The psychologist means by delusion a morbidly defective type of opinions, while hallucinations are false perceptions. When a man groundlessly and morbidly accuses his family of trying to poison him, this is a case of delusion. When a patient hears unreal voices talking about him, this is a case of hallucination. Of course, phenomena of both kinds may be combined, and in some forms of insanity they always are combined. The distinction, however, is important; because, from a purely psychological point of view, a delusion is, in general, the sign of a deeper derangement than is a mere hallucination. The latter may be due to transient conditions of cerebral excitement. The former, the delusion, stands at once for the distortion of one of the most significant of our habitual functions—namely, the function of judging our relation to our environment. And it is a universal rule of psychological diagnosis that the more general the habit of brain which has been really deranged (and not merely hindered by temporary emotional disturbances), the worse is the abnormal indication. To forget a familiar name is possibly an abnormal, but is so far a decidedly superficial incident. To hear a voice when none is really speaking may be a very grave matter, if it becomes chronic; but of itself, as a single incident, it indicates merely a state of excitement which may soon pass away. But coolly to insist, without any objective ground, that you are indubitably aware that your

wife means to poison you—this indicates an established "set" of brain which (unless the cause is an acute and transient delirium) is likely to prove serious in proportion to the number and the generality of the altered habits which must lie at the basis of the perversion. (On the "general" habits of the brain, compare what has been said in § 16 near the end.)

On the whole, other things being equal, the cooler and less emotional a delusion is, in the tone with which it is held and expressed, the worse is the indication, because the more does this state of things indicate a direct perversion of the more general "set" of the brain. The delusions of a fever delirium are largely secondary to violent emotions, and so in their contents they are confused, and they may soon pass away, when the temporary brain poisoning is relieved. The wild, fleeting, and scarcely utterable delusions of an ether-intoxication are as massive as is the stormy, emotional outburst of the intoxicated condition, and they vanish with recovery. But an experienced insane patient may hold to his chronic delusions with considerable coolness and clearness of head. His power to do so may of itself indicate the hopelessness of his state. Especially grave is the tendency of cooler delusions to get thought out, or "systematised," by the patient. For thus all of a man's habits of brain get wrought over into the service of his delusion, and then he can never even conceive the way out. All of the foregoing indications must of course be modified by the circumstances of individual cases, but these suggestions may serve as hints of the principles of psychological diagnosis.

A morbid delusion, for the rest, is by no means the same thing as a foolishly false opinion. When one gets superstitions, or other absurd views, by hearsay, and from the tradition of the social order to which one belongs, the process of acquiring the false belief is then normal, however false the faith. There is no view so ill-founded that perfectly sane men may not hold it, given a sufficient weight of social tradition and of popular ignorance. But the peculiarity of the morbid delusion is that a man does not get it by normal methods—*e. g.*, by accepting current social traditions—but comes upon it alone, as a matter of his private experience. The exceptions to this rule are, for our present purpose, insignificant. Moreover, the morbid delusion has always a characteristic reference to the patient's own private fortunes or dignity, instead of being, like the socially acquired tradition, a matter which concerns others quite as much as himself. A morbid delusion may, indeed, assume a philanthropic seeming, but a closer inspection always shows that the deranged man is to an abnormal degree at the centre of his false world. It is he who, of all men, is most persecuted or exalted.

So much must here suffice as a mere hint as to the greater intellectual abnormities. Very common, however, is another problem—viz., that of the diagnosis of mere eccentricity of intellectual life, apart from any spe-

cifically manifest perversions. It is normal for us to acquire the most of our intellectual habits, by imitation, from the society to which we belong. Our social experiences are normally the most potent of all our experiences. Speaking, reading, writing, investigating, the knowledge of our profession or business, the thoughts of our daily life—these are all determined for us, in great measure, by our guardians and teachers in early life; by our friends, comrades, rivals, and other fellows in later life. Hence the most of our intellectual habits ought to be of a sort that we have in common with many of our fellows. When one's intellectual life varies, however, from the average intellect of his tribe or of his class, then, according to the degree and the noticeableness of the variation, one is called "striking," "individual," "original," "independent," "a man of parts," "a genius"; or, in less kindly speech, one is declared "eccentric," "queer," "quaint," "odd," "a fool," or "a crank." Now, it is manifest that variations from the average intellectual type are, within certain degrees, advantageous to both the individual and the community. The best communities cultivate certain types of originality. One habit that ambitious young people often catch by imitation is the very habit of seeming not to imitate—*i. e.*, of striving to be original. On the other hand, there is a good deal of intellectual originality in the asylums; and certain forms of eccentricity are of themselves abnormal. The question of diagnosis often offers itself: Is this particular sort of intellectual eccentricity (*e. g.*, in this young man) a mark of wholesome talent or of dangerous crankiness?

Eccentricity.

The answer must be founded upon principles, some of which can easily be stated. Conformity to one's environment is, as we must insist, in the end the test of normality. But some original men first win their environment over to conform to them; and herein they show, even through an early conflict with the environment, their higher sort of capacity to find a place in their world. Moreover, all young men have to spend some time in learning what they are fit for before harmonious life becomes possible. Thus the test of the conformity of a given intellectual life to a given environment must be applied, especially in early life, very cautiously. Some eccentric young men are so because they are "ugly ducklings" who will turn out swans. Still others, however, are rather geese among swans. The psychological observer is therefore not afraid of the mere show of eccentricity even where it is great in degree. It is the sort of eccentricity that such an observer tries to consider more carefully before he judges. And now, a general test of the abnormally eccentric intellectual life, where it involves as yet no graver disorders—no delusions, no violently morbid emotional states—is to be found in much the same region as the one in which the morbid character of true delusions was just seen to manifest itself. The morbidly eccentric intellect is one

in which the interesting experiences are to an extraordinary degree centred about matters which have too little social concern, and too much private concern for the morbid individual himself. This test is not applicable, of course, in childhood, since all young children are extremely self-centred. But it is, despite the normal selfishness of youth, already fairly applicable in the later years of youth. A young man may indeed be very extremely and grossly "self-centred" and intellectually commonplace *at once* without much mental danger; for he then belongs to his herd, and his herd will take care of him. His socially submissive instincts may, and probably will, offset the selfish grossness of his conscious aims. He will live, like the rest of his kind, a poor intellectual life, but a normal one. He will think mostly about his private concerns, but still society will, after all, determine *what* he shall think about them. Not so, however, is the eccentric or "original" mind fatally protected by the instincts of the herd. And where an intellectually eccentric or original mind is extraordinarily devoted to thinking over, dwelling upon, planning, the private success, the exalted dignity, the selfish preferment, of just this individual, then, *in the combination of intellectual eccentricity and selfish narrowness of personal aim*, there are strong marks of danger. To be sure, even such a being might have the brain of a Napoleon; but that is, to speak mildly, uncommon. On the other hand, a naïve eccentricity of intellectual life, sincerely, not falsely, devoted to objective concerns (mathematical problems, scientific pursuits, the study of nobler literature, the pursuit of a modest but effective philanthropic career), is consistent with a true promise even where the anomaly is relatively great. A noteworthy test, then, is whether the anomalous young person really looks rather without than within. One need not add that to apply such a test needs often a pretty close scrutiny. Selfish greed may wear many cloaks and may use noble phrases.

VII. THE WILL, OR THE DIRECTION OF CONDUCT.

§ 32. The life of the Will has already been defined, in certain of its aspects, in the foregoing discussions of the facts of feeling and of intellect. It is therefore possible to be here especially summary in our method of treatment.

The Will is the sum total of our mental states in so far as they involve *attentive guidance of our conduct*. How such guidance is possible we have therefore next to explain.

Expression of Brain-processes.

All definite brain-processes tend to express themselves without in movements by which we adjust ourselves to our environment. Many of these movements pass more or less unnoticed by ourselves. But all of them, in proportion as they are marked and effective movements, tend not merely to

result from brain-processes, but to influence, in their turn, the very brain whose processes have initiated them. If one's arm moves, the movement is itself a fact in the world outside the mind, and, like any other outer fact, it may be once more perceived and remembered. One sees the arm move, feels the sensations of muscular contraction, and is in still other ways advised through one's sense-organs of the processes which the arm's movement involves. Moreover, if the arm, by moving, accomplishes something definite, such as an act of grasping, one perceives the resulting movements of the object grasped. If the arm is engaged in writing or in drawing, one sees on paper the lines which the moving hand traces. In all such cases one observes, then, the results of one's doings. And so, in short, *one's own activity constantly becomes itself a part of one's experience.* If an experience is any mental state in so far as its relation to past states guides our present thoughts and deeds, and if all of our mental life accompanies those expressive movements, or tendencies to movement, which the brain initiates and guides, it follows that *every mental state has an aspect in which it may be regarded as involving an experience of our own fashions of action, or of our own attitudes, towards our world;* for at every instant we are acting, or tending to act, and so at every instant we are experiencing the results of our own activity, or of our own tendencies to action. So far, then, there is an aspect in all of our mental life which constitutes this life *a series of experiences of our own doings*, a series which can take on, by the laws of intellectual growth, a highly organised and rational character in proportion as our habits of conduct become themselves regular, uniform, and complex, and are observed by ourselves for what they are.

Experience of our own Activity.

But just as our activity has its intellectual aspect, in so far as we constantly learn what we have done and are doing, so, too, this activity has also its passing value for us in our direct feelings. What we are doing at any given moment is satisfactory or unsatisfactory to us. Action which, by virtue of its passing character as a felt mode of action, relatively satisfies us, we call an expression of our desires. When an action is such that the feeling which accompanies it is one of predominant dissatisfaction, the act opposes our ruling desires, and tends to be inhibited accordingly. *Thus, then, every mental state tends to have, as a fact of feeling, an aspect which embodies our current relative satisfaction or dissatisfaction with our own momentary doings. A desire means a tendency to action, experienced as such, and at the same time felt as a relatively satisfactory tendency.*

Desires.

So far, then, we see: (1) That our own activity forms constantly a part of our experience; (2) that this same activity constantly results in a modification of our feelings of satisfaction and dissatisfaction in what

we are doing. If one combines these two aspects of our inner life, one can say that together they involve *a vast experience of our own desires and aversions, of our own doings and inhibitions, and of the inner results of these doings and inhibitions, together with a constant play of feelings of inner content and discontent with our own motor processes, and with the tendencies or attitudes which accompany our partially suppressed movements.*

Thus we briefly characterise so much of our inner life as constitutes the world of desire and of its outcome. Thus viewed, our minds appear as full of passing impulses, of tendencies to action, of passions, and of concerns for what we take to be our welfare. All these impulses and concerns get woven, by the laws of habit, into systems of ruling motives, which express themselves without in our regular fashions of conduct. The whole of our inner life, viewed in this aspect, appears as the *active side of our consciousness, or as the will in the wider sense.*

The Will in the Wider Sense.

But it remains to lay stress upon one further aspect, by virtue of which the world of the more or less organised impulses, concerns, passions, and other desires, gets its fully developed character as the world of the will in the stricter or more proper sense. We not only observe and feel our own doings and attitudes or tendencies as a mass of inner facts, viewed all together, but in particular *we attend to them with greater or less care*, SELECTING *now these, now those tendencies to action as the central topics in our experience of our own world of desire.* The process of attention (§ 30) often has as its objects not only external facts, or facts of sense-perception, but also desires, actions, inhibitions, tendencies to action, concerns, feelings, passions—in brief, whatever constitutes the active side of our nature. But to attend to anything is to emphasise that object, to give it "relief" as against the rest of what is in our minds. *To attend to any action, or to any tendency to action, to any desire, or to any passion*, is the same thing as "to select," or "to choose," or "to prefer," or "to take serious interest in," just that tendency or deed. *And such attentive preference of one course of conduct, or of one tendency or desire, as against all others present to our minds at any time, is called an act of will.*

An Act of Will.

The Will is, when viewed from within, *the attentive furthering of our interest in one act or desire as against another.* The act or desire is in itself something of more or less interest to us. If we attend to this act or desire (§ 30) we further our interest in it. The furthered interest results in a clearer consciousness of the act or tendency in question. But the very existence of such clear consciousness implies (by the principles indicated in § 20) that the condition of brain which naturally expresses itself in just this form of outward activity is, at the moment of clear

consciousness, a predominant condition of the brain. The furthered interest, if intense enough, therefore means, on the physical side, that the form of activity in which we are interested gets an actual outer expression *just as soon as our attention sufficiently prefers the thought of this act to the thought of any other act.*

To think of any sort of activity, therefore, already implies a tendency to this form of activity (cf. § 29). And actually to will a given act is to think attentively of that act to the exclusion or neglect of the representation or imaging of any and all other acts. Whenever one idea of action or one type of desire becomes really predominant in consciousness through attentive consideration, then the action or desire in question at once gets carried out until some restraining idea arises and in its turn gets attended to. Choice bears, therefore, the same relation to actions that intellectual attention bears to images, ideas, or thoughts; and in discussing the phenomena of attention we have already discussed all that is essential to the comprehension of an act of will. Upon the physiological accompaniments of the will we need, therefore, say nothing further at this point.

It remains to note here only one or two considerations of no small practical moment. The first is that, strange as the statement may seem, we can never will any really novel course of action. We can directly will an act only when we have before done that act, and have so experienced the nature of it. The will is as dependent as the intellect upon our past experience. One can indeed will an act which is sure to involve, in a given environment, absolutely novel consequences; but the act itself, so far as one wills it, is a familiar act. Thus a suicide can will an act which results in his own death, and so far he seems to be willing something which wholly transcends his past experience. But, as a fact, the act itself which he makes the direct object of his will (*e. g.*, pointing a pistol and pulling a trigger, or swallowing a dose) is itself an act with which he is long since decidedly familiar. One can will to visit a far country, to engage in a new sort of speculation, to choose a still unfamiliar profession, to marry, or to do anything else whose consequences one cannot foresee. But it is the consequences that are novel; the act which one directly wills is not novel. What one does at the decisive moment is to buy a ticket, to sign one's name, to say "Yes," or otherwise to repeat deeds whose contents are already perfectly familiar, while the circumstances under which they are willed may make them to any extent momentous. But, on the other hand, one cannot will to fly, because one has never learned how. We can thus will to do only what we have learned to do. "Control yourself," says the stern adviser to the spoiled child. But the adviser upbraids in vain. How *can* the spoiled child will to control himself if nobody has

The Will not Original.

ever shown him, by an appeal to his imitative instincts, what self-control means? Our will, psychologically viewed, is thus an absolutely unoriginal power. It gives back what experience has taught it. But, on the other hand, viewed with respect to its outer consequences, the will, if not in itself original, may be to any extent *originative*, because to repeat such an unoriginal act as signing one's name, or saying "Yes," may, under given conditions, begin a new life for the doer, or even for the whole world in which he moves.

Basis of the Will.

Closely connected with the foregoing consideration is the further principle that, before we can come to possess a will, we must first perform numerous and complex acts by virtue of the inherited tendencies of the brain (see § 16, in the latter portion). Such original tendencies of the brain are the source of our human instincts (§ 13, 2). The will is based upon instincts. These get moulded by experience. The resulting acts, gradually organised by the laws of habit, come at last to our notice, in so far as our doings are themselves a part of our experience. The accompanying feelings colour our acts so that they are also expressions of desire. Then attention fixes now on this, now on that conceived act, tendency, or desire, according as our interest plays over the whole series of such experiences of our activity. The emphasis which attention gives, in the end, to the ruling idea of action is the inner and psychological aspect of our current act of will or of choice.

Growth of Language.

The growth of language in any child is an excellent example of the evolution of the will. Inherited instinct expresses itself in the infantile actions known outwardly as cries, and later as more vocal sounds — babblings, primitive efforts at wholly meaningless articulation. Then the child begins to observe these acts of his own, to feel satisfaction in them, to desire their repetition. The result, so far, is the development of a chaos of vocalised expressions, but not yet anything resembling true speech. However, long before this process is completed another inherited instinct intervenes. The child is imitative. This instinct involves complex processes which result in making the child's vocal noises tend to resemble those which he hears from other people. This resemblance, once more noticed by the child, also becomes a much-desired ideal; and hereby the child first gradually learns and then definitely wills to reproduce the utterances of others. Then there is added, while these processes are still under way, the intellectual experience that many of the sounds uttered by other people mean something: are names for things, or for feelings, or for purposes. This, erelong, shows the child that he too can express his meaning by using the right sounds. Now he becomes selective, attentive to speech as such, desirous of harmonising what he says with what others say or understand; and finally, upon the basis of all these elaborately

moulded instincts and habits, the intelligent will to talk takes form, and henceforth the child says whatever he predominantly and attentively desires or chooses to say, whenever he is thinking of speech rather than of any other mode of activity.

§ 33. While the expression of our minds in and by our conduct is the one great tendency upon which all knowledge of mind from without, and all the serviceableness of our mental life for the interests of society, depends, it is nevertheless the case that the practical study and training of the will are almost always regarded as secondary to the practical study and training of the feelings and the intellect. The reason for this is obvious. Apart from intellectual training, the life of our desires is mainly the expression of our inherited instincts, which nobody can hope to eradicate altogether, or to enrich by the addition of any entirely novel instincts. What can be done for us is to organise our planlessly numerous inherited instincts in such fashion that there shall result valuable and consciously directed habits. The devices for accomplishing this aim are largely appeals to our universal human love of social imitation. Hereby we "learn how" to act aright; and unless we have "learned how," one appeals to our will in vain. Hence what appears as an intellectual acquisition—a "learning how" to be good, industrious, skilful, self-directing, etc.—is always prior to the successful moulding of the will as such. As every such "learning how" involves interests, the feelings are appealed to at every point. But the will itself, whose proper moulding is indeed in one sense the goal of all education, seems to be capable of only this indirect approach. Or, again, to teach one to will involves teaching him first to take note of his own conduct. But to teach him this you must first establish in him the desired conduct. You must get him to do before he has consciously willed this particular sort of doing. The involuntary conduct must precede the voluntary; but the right sort of involuntary conduct you can only establish through appeals to the feelings, and through presenting the fitting objects of knowledge to the intellect.

Inherited Instincts.

Training the Will.

For the same reason disorders and defects of the will never exist alone. They always involve alterations either of the feelings or of the intellect, and must be studied in connection therewith. It is noteworthy that insanity, in the popular mind, is usually conceived as primarily an intellectual defect rather than as primarily a defect of the will, and this despite the notorious fact that insanity can only manifest itself through some sort of "queer" or "wrong" expressive action.

Disorders and Defects of the Will.

Nevertheless, it is often important to consider mental defects or disorders from the side of the will. So viewed, the "disorders of the will" may be said to manifest themselves in three general types. The first

type is that of the absence or serious impairment of the ability to carry out important voluntary acts, when such acts have already been in the past learned as well as often performed. This first defect is often known by the rather vague name of "weakness of will." A technical name is "Aboulia," or morbid will-lessness. The second type of defects of will is that of the chaotic or "segmented" will, whose plans do not hang together, whose action is morbidly impulsive, capricious, inconsistent, or inwardly anarchical. The third type of defects of will appears in those morbidly perverted persons (*e. g.*, in morbid criminals) whose activity, without being confused or chaotic, is still steadfastly such as fails of any tolerable adjustment to the environment, and especially to the civilised social environment.

Aboulia.

The first type, Aboulia, is sometimes a manifestation of the temperament as such. In such cases one naturally looks for its cause in the emotional "undertone" (cf. § 25). The deeply hesitant or morbidly indecisive man who, despite having learned how to do a given thing, and despite his clearly knowing that it is to his interest to act, still remains permanently fast bound in a Hamlet-like incapacity to will anything for himself at the important moment, has become a favourite topic for literary portrayal. Hamlet notoriously refers his own defects of will to intellectual causes. His "native hue of resolution" is "sicklied o'er with the pale cast of thought." But such defective will may appear with a less obvious intellectual basis than in Hamlet's case. Then, however, the defect would probably be definable, in emotional terms, as the pretty constant presence of some emotion of painful timidity or scrupulosity, in the presence of which all very decisive action seems in general unsatisfactory. "Apathy" of temperament—*i. e.*, an enduring state of abnormally depressed emotional sensitiveness—might have the same effect.

But Aboulia is a frequent acute symptom in cases of more or less transient nervous exhaustion. In a measure, every one can occasionally notice such a defect of will as an incident of normal weariness. At such times we may find it especially hard to make a decision, even when we seem to ourselves clearly able to see just what decision ought to be made, and even while we feel that, as we say, we "want" or even "long" to decide. The feeling of helplessness is then itself often extremely painful. If by chance we actually begin a decisive course of conduct, then the feeling that we are "committed" gives a great sense of relief, and the defect of will may at once, for the time, vanish altogether.

In cases of nervous exhaustion, such Aboulia is an inconvenient complication, in so far as it tends to set a habit of indecision which may long survive the period of exhaustion itself. In itself, however, this acute Aboulia is apparently no very alarming incident. The nervously exhausted

man should be carefully relieved, so far as possible, from every necessity of making difficult choices. He should, therefore, if possible, "resign his will" into the hands of some one, or at most two or three competent and harmonious advisers, and he must be protected from every confusing variety of plans. On the other hand, whenever decisions are really necessary, he should always be gently but firmly helped to a quick and irrevocable choice, since hesitancy is a very exhausting incident in his experience, and since even a poor choice is often better for him than doubt. But if such care is taken, the Aboulia itself is no very serious symptom. Sometimes one meets with light cases of weariness where such Aboulia is, in fact, almost the only discoverable morbid symptom, and these cases are actually encouraging as to the outlook for quick recovery.

Segmented Will.

Much more manifold are the chaotic disorders of the morbidly inconsistent or capricious will. Temperaments abound which are characterised by phenomena of this kind, and in both acute and chronic disorders the disorganised will is a well-known symptom. This, for example, is especially true in hysterical disorders. But ordinary nervous exhaustion is frequently burdened with enemies of the kind. One often sees, for instance, the man who forms morbidly one-sided resolutions for the conduct of this or of that portion of his life. He means to permit only this or this train of thought, or to exclude wholly this or this possibility of temptation. Over the well-meant but possibly useless resolution he grows morbidly conscientious, and upbraids his friends for not sufficiently appreciating and aiding his efforts. Meanwhile, however, he freely indulges himself in graver defects than the one which he is so elaborately correcting, and inconsistently encourages even the very tendencies which he is fighting by giving them a false importance through his over-wrought self-scrutiny. In more hysterically disposed cases such defectively insistent broodings will be subject also to vast changes of plan, so that the sufferer alters his religious faith, or the whole ideal of his life, without any clear reason, and throws to the winds a whole system of good resolutions in favour of some other equally useless scheme. The habit of mere fickleness may thus become finally prevalent over all other habits (cf. § 16, at the end). One thus finds people who acquire a "mania" for changing their religious faiths or their callings.

Disorganisation of Will.

Simpler, but often very stubborn, are the phenomena of disorganisation of will in case some one more or less generalised motor habit becomes rebelliously insistent—*e. g.*, the habit of counting or of examining gas jets, locks, etc., to see whether they have been safely adjusted, or of asking useless questions about some sort of topics. Disorganisations of this kind appear in many patients on the basis of a defective hereditary constitution. But in

children and quite young people they are also often present as mere disorders of development, which pass away with maturity. And nervous exhaustion can bring them on as acute symptoms in otherwise unburdened people. A surprisingly large number of such morbid habits can often exist without destroying or even seriously endangering in other respects the general capacity of the brain that suffers from them ; and the fears of an impending general insanity which they often arouse are therefore very frequently unfounded. On the other hand, they are certainly grave inconveniences, and are not to be trifled with. They are best treated, apart from the medical care of the patient's general health, through a discreet moral support, given by a competent adviser, who can often help the patient to or towards a relatively effective and cheerful ignoring of his enemies.

In estimating all such defects the rule holds here, as in case of the defects of the intellect, that the stronger the attendant emotional colouring of the disorder, the more hopeful, other things being equal, is the outlook. The cooler the emotional tone of the sufferer from a defective will, in so far as concerns his immediate feeling about his disorder, the fewer are the means of influencing his morbid state. And this finally suggests why the morbidly perverted characters whose wills are relatively well organised, firm, and cool, but whose behaviour is intolerable, are in general incurable. In consequence, we may as well here abandon the task of further describing such characters, whose mission in the world seems to be to illustrate the variability but not the healthy docility of our human nature.

Morbid Perversion.

NOTE BY THE EDITOR ON THE PRACTICAL APPLICATIONS OF PSYCHOLOGY.

It is a common mistake to suppose that psychology is a branch of science which has little bearing upon the practical affairs of daily life—that it is a matter of pure theory, which has its place among the abstruse studies of philosophers far above the heads of ordinary people, and as far removed from ordinary business as are the higher mathematics or philology. The article by Prof. Royce shows clearly that psychology has a most intense "practical" importance; it is concerned with every phase of human thought, and therefore of human action. It deals not only with the human mind in the abstract, but with the mental development of

every individual human being. Upon the application of its principles to the growing child depends to a large extent that child's whole future—its moral character, its mental ability, and its happiness. It simplifies many problems connected with education by showing definitely *how* children learn and *why* they learn. It shows the ways in which habits of mind are acquired, and enables us to try in a rational manner to guard against the formation of those which are bad, and foster and strengthen good habits already existing and to establish new ones.

Every one who has to estimate the character of his fellow-men (and who has not to a greater or lesser extent?) consciously or unconsciously must draw his conclusions—if they be correct *conclusions* based upon logical processes, and not mere *guesses*—by applying psychological methods. The best training of children can only be carried out by one who understands the relations of cause and effect in the mental world so far as these relations can be understood. Psychology does not pretend to explain *what* thought is; it deals with the phenomena exhibited by the thinking being, and tries to learn the nature of these phenomena and their relations to one another. The psychologist can no more explain the exact nature of thought than can the physicist explain the nature of energy. The latter studies the various objective forms of energy—such as heat, light, electricity, gravity, and motion—with a view of learning the laws which determine their behaviour and relations; the former does the same with phenomena of energy exhibited by the brain when in action.

IV.

PHYSICAL TRAINING.

By JOSEPH HAMBLEN SEARS, A. B.

INTRODUCTION.

The life of an ordinary man or woman, boy or girl, of to-day is very different from what it was a hundred years ago. Every boy or girl who wishes to grow up well educated and prepared in every way to take his or her part in the world has a much more difficult task than his father or mother had. There is more to learn, more that must be known before a start can be made; and at the same time the development of the modern city offers far less opportunity for the maintenance of a vigorous mind and body. We have to do more, and are in poorer physical condition to accomplish it than our parents.

For both these reasons it is the more necessary that a boy or girl, a man or woman, of to-day should set for himself or herself regular and systematic work that shall tend to strengthen the physical body and fit it to furnish a constitution capable of doing what the mind requires.

Increasing Necessity for Physical Training.

As it is neither wise nor possible to lessen the work laid out for us, the only other course is to find a means of preparing our bodies to withstand the greater strain, to supply that physical education of the muscles and tissues, which is to fit them to keep pace with the increasing capabilities of the human mind. And the fact that such men as Gladstone, Bismarck, and hundreds of others carry the weight of enormous responsibilities and retain the capacity for extraordinary amounts of work far beyond their threescore and ten years is proof enough that this can be done.

The body is nothing more nor less than a beautiful machine. It is well made at the start—that is, if there are no hereditary weaknesses of moment. The machine simply needs care, attention, and proper use, to make it run smoothly and accomplish infinite tasks. If it is imperfect in any part from whatever cause, and yet not so poorly made as to prevent use, the machine can be improved by careful study of the imperfect parts,

and systematic work to correct their faults. This machine, like any other, needs rest—rest in its true sense, not lack of use; for, like a piano, it will soon get out of tune if it is not constantly used; but, like the piano, too, it will get out of tune if you drum on one note constantly, if you maltreat it or do not watch it. Whatever philosophers may say to the contrary, the brain and the mind are just as much machines as the body, all three being so closely connected that when one is out of tune it can not be played in harmony with the others. Wherefore physical training, as treated in this article, is not only exercise of body, but, to a certain extent, of the mind and brain also.

Possible for Every One to take Some Exercise.

Naturally, theory and practice do not always run the same road in amicable companionship, but these little disputes by the way do not in the least alter the correctness of the theory, nor furnish argument or excuse for the total disregard of it. Circumstances may, and often do, make the theory in part impossible to put to practical use. Then, for the time, the best that can be had must be taken without a murmur; and, keeping the theory before us, we must endeavour to come as near it as circumstances will allow. The commendable advantage of physical training over analogous subjects is that the theory can be put into actual practice here far more frequently and far more perfectly than elsewhere. Every one can bathe; every one can eat moderately and judiciously; and every one can play and exercise twenty minutes in a day. And, after all is considered, what more is there in physical training?

It would be impossible in this short article to go into an exhaustive treatise on all the branches and theories of physical training. There are books upon books that do this as well as it can be done, and any one who cares to, or who cultivates a desire to do so, may find all he wants to know in these, or from the hundreds of trained instructors in this important subject. The purpose of this article is rather to show, if possible, the importance of physical training itself in every-day life, and if the result of its perusal creates that desire in the reader, leading him to go further into the study and give his mind and body that attention which so beautiful a machine deserves, the purpose of the author will be accomplished.

Regularity in Exercise.

It is a law of life that nothing really great is accomplished suddenly; nothing is achieved by single feats of any kind, but by slow, persistent endeavour, by constant practice, and by that steady, gradual movement toward the accomplishment of a great result, which is like the building of a mansion brick upon brick. And if this is a law of life, it is most certainly a law of health, that no complete physical or mental power is attained by single isolated instances of training, but by the aid of the most regular, steady,

persistent, and constant physical exercise, always temperate, never exaggerated, the judicious placing of one small brick each day on the building of physical health.. The theory is clear enough; and that theory should be stated at the start, as if it were entirely possible in all cases, since, as I have said, it is possible to him who will but have the courage to undertake it and carry it out. Still, as hundreds of matters interfere, and, most important of all, as it is so difficult for human nature to be regular and methodical, it will be necessary, after briefly stating the theory, to offer in quite as brief a form some suggestions as to the best courses to pursue, where, for the moment at least, circumstances appear to be too firmly set to allow one person or another to follow it in detail.

Every result in physical training has its reason for being what it is; and the best way to learn how to accomplish a result is to search out and study its cause. The cause—that is, the theory of perfect physical condition—can be stated in half a dozen words: *exercise moderately and temperately for a short space of time regularly at the same relative hour every day of your life.*

The regularity of the exercise accustoms the body to a certain stimulus at a certain time; the habit is acquired, and the exercise adds just so much healthy strength and vitality to the frame, increasing the muscles moderately to a healthy development, where they are maintained at a normal standard. If an unusual or unnatural physical exercise is taken, the result is a shock instead of a normal addition to the body's strength, and hence the result is injurious. The heart is overtaxed, or the lungs are congested, or the muscles are fatigued, or a hundred other injurious effects are accomplished instead of the one correct thing—steady physical advance.

Exercise Out of Doors.

Manifestly this temperate, regular daily exercise should be taken out of doors. The air is purer under the sky than under a dusty ceiling, which, when jarred even in the slightest degree, drops thousands of particles that go into the lungs to produce, we may be sure, no salutary results. There is more room out of doors in which to perfect the exercise. There is a stronger movement of the atmosphere that stimulates respiration. The springy ground is quite different from a wooden floor. Most important of all, some of the finest physical exercises are, from their very nature, impossible within doors. It should be remembered, also, when out of doors is mentioned, that it is the country and not the city pavement which is meant.

Furthermore, it is quite as manifestly true, after a moment's consideration, that this daily exercise should be undertaken in the daytime rather than at night, if for no other reason than that God meant men to work in the light and sleep in the dark. But it has been too often

proved to need argument here that physical exercise under the rays of the sun is quite another thing from night work of the same sort. The sun warms and stimulates the body, makes a pleasure out of what is to be done, and in every way serves as a help toward the result for which the exercise is undertaken. Then, too, many of the best exercises require light, and good light at that, for their accomplishment — for example, most games.

Exercise in the Daytime.

It may not seem at first glance quite as necessary as the foregoing laws of exercise to say that all general exercise should be in the form of a game rather than in some especial series of physical movements; but, upon reflection, this will be found to be quite as true as what has already been said. We have all seen men, and perhaps some of us have been through the same process, who firmly believed they were exercising and relieving the tension of mind and body after a long and close application to work when they went through a series of dumb-bell movements, whereas, in reality, their minds not being required in the course of this exercise, only the body was receiving its training, and that merely in a perfunctory manner. To make exercise beneficial, the mind and brain must be as much employed as the body, and this can only be done, except in a few isolated cases, by making the exercise itself some form of game requiring brain work and embodying the idea of victory and defeat.

Exercise in the Form of Games.

Let no middle-aged, no old man think that the time has gone by for him to receive any good from physical exercise. One of the most satisfactory features of the whole practice of training is the immediate results it shows in persons of any age. A few short weeks of this temperate, regular development makes a different human being of the octogenarian. And, in like manner, the popular prejudice, now fortunately disappearing, that women and girls are in some way different kinds of beings from men and boys, and do not require any physical exercise, is as absurd as it is disastrous. If anything, women should give more thought to their exercise than men, more thought to the determination of the method and the duration of their exercise; for having, in a certain sense, more delicate organizations, they require that more thought and more care be put into the question of their physical training.

Finally, the question of physical training is not for the good of the body only. It is probable that exercise of a healthy sort is a great preventive of crime and of intemperance in all forms, one of the greatest strengtheners of the moral sense that exists. But this subject is too extensive even to be touched upon here. There is only room for the statement of the fact that college authorities unanimously declare that our modern American college athletic games, and all the training that accom-

panies them, have done the community an inestimable service in raising the standard of morality and temperance among our young men to a point that has never been reached in the United States before.

OUTDOOR EXERCISES.

Two Objects of Exercise.

It is important to remember, in discussing the question of physical training, that two distinct sides present themselves, and that the distinction of one from the other must be carefully borne in mind when any work on the subject is under consideration, as well as when the subject of individual development is to be discussed. Exercise is taken up either as a means of maintaining already good health in a normal body, as a means of counteracting the influence of sedentary life in which little or no physical movement bears a part, or to develop constitutionally weak parts of the body, or muscles, or organs that have been rendered chronically weak by the particular occupation of the individual in question. The ordinary city office work, which means constant sitting at a desk six days of the week, the similarly ordinary occupations of a woman within the house and in the midst of her domestic duties, require general action of the body as a whole in order to counteract the lack of exercise in themselves. Lungs which are constitutionally weak, which are only employed within doors cramped over a desk or sewing table, a stomach and digestion that are chronically out of healthy working gear—these and a thousand others are special parts of the body that require special attention and special athletic exercises, not only to restore them to normal condition, but to prevent them from developing into incurable diseases.

A large part of this article will be given necessarily to the former, since a special weakness is different in its details in individual cases, and should have the direct personal care of a physician or some one who understands physical culture. Few principles can be given for the improvement of these special weaknesses, and those only the most general. As, however, exercise for general purposes of health is what the great majority of persons require, and as any one who is really ill is likely to go to a physician of his own accord, the practice of general athletics is the subject to be discussed here.

OUTDOOR GAMES.

Outdoor games are, without question, the best methods for maintaining normal health for such persons. The first principle to be laid down is that no man or woman should allow a day to pass while he or she is well without taking exercise in the form of some game—that particular game which contains the largest amount of general exercise and which is

available when the facilities of the individual's surroundings, the time at his disposal, and the size of his purse are taken into consideration.

Naturally one can not play polo every day in the year. It would not only grow wearisome, but would overtax the strength, and in time injure the health instead of benefiting it. Most real athletic games present the same difficulty. But it should be borne in mind that one who plays polo or tennis, or anything else of the sort, once or twice a week is from this very fact stimulated to keep himself what is called "in training" all the time. On the days when he does not play his games his exercise should be taken in something more temperate, involving less time, less preparation, and consisting perhaps of nothing but special development exercises. The latter alone will not accomplish what is intended by physical exercise. Combined with a vigorous game, they do much, perhaps nearly as much as the daily practice of some easily undertaken games.

Polo.

There is little doubt that polo as played at present contains a greater amount of physical exercise distributed over every conceivable muscle of the body than any other sport, at the same time that it occupies the mind to the exclusion of all else. Every one of the leg, back, abdominal, chest, shoulder, and arm muscles are at work all the time. The player is using his lungs in the freest possible way, and he has the added exercise of keeping himself on his horse, which is constantly charging in every direction, which must be guided, steadied, and controlled with one hand while the other is engaged in managing the mallet. And through it all the player's mind and brain are busy with the pony as well as with the course of the ball and the progress of the game. There is never the same movement repeated a second time. The whole principle of the sport is infinite variety, bringing every part of the body into play, bringing every faculty of the mind to bear. Yet, though precise and accurate repetition is absent, the amount of skill required can be understood only by him who has played the game for years. Polo is, however, beyond the reach of most men. It is very expensive; it is impossible for a man beyond middle age, on account of the extraordinary quickness required; it is impossible for one whose weight is over about one hundred and seventy-five pounds, as a pony can not carry even that weight with the degree of quickness and ease necessary to the game. Furthermore, polo, like all the most vigorous exercises in the form of games, is dangerous to life and limb, for a collision of two men on their ponies often results in serious injuries. For him who has the time, the money, and the physique to play it, polo, nevertheless, is without a peer in athletic sports. As an exercise pure and simple it should not be played oftener than three times a week, and only during that part of the year when the turf is in a soft condition.

From Harper's Magazine.

Fig. 1.—Polo: "On the Ball."

Football.

Football as played in college to-day—that is, either the American game of Rugby Union (Fig. 2) or the English Association—has all the points brought out in polo, except that the pony is wanting, and with him goes some of the completeness of the exercise. Football is more exhausting, and can only be played at its best for a short time in the year when the temperature is warm enough

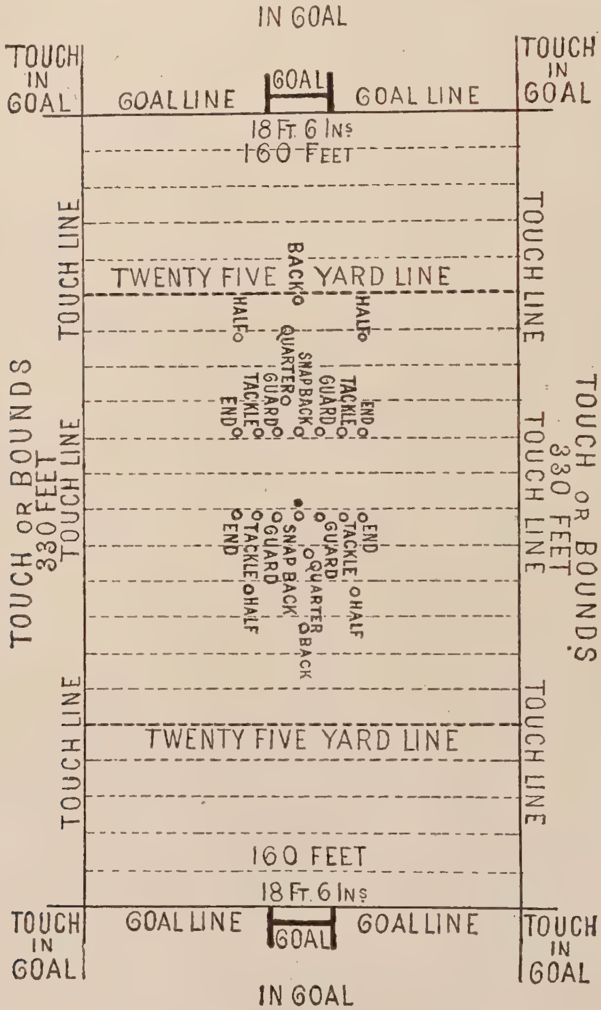


Fig. 2.—Diagram of football ground.

to furnish soft turf but not so warm as to exhaust the body. It embodies, however, all the points which make exercise beneficial. Every muscle of the body is constantly in use during the game, and at the same time the sport trains the mind in many of its most valuable qualities. It is

distinctly a young man's and boy's game, but as such it has done an inestimable amount of good, both morally and physically, to the youth in colleges and schools. Fig. 3 gives a good idea of the game at its height. The difficulties of football as a systematic exercise are great, however, since twenty-two men are required to make up the two elevens, and the better part of an afternoon is required for the playing of a single game. For schoolboys in towns and cities there is hardly a finer and more manly sport to be found, and the popular prejudice against it as an ungentlemanly game is misplaced; for while, like boxing, it offers opportunities for vicious natures to revel in, it is a magnificent school in self-control, courage, self-reliance, keen, quick thought, and the habit of instantaneous decision. The infinite variety of a game, or even of an afternoon's practice, is what places it above most sports as a general physical trainer.

FIG. 3.—FOOTBALL: A SUCCESSFUL "TACKLE."

An important consideration in both polo and football is that they should not be played by any one who has a tendency to heart or lung trouble. Such a tendency is often not discovered until one of these vigorous sports is taken up. But as soon as it is discovered a physician should be consulted. Either game should be played only after considerable athletic training. Indeed, they are only for the naturally healthy, who have time and money to devote to some extraordinary exercise.

In lacrosse (Fig. 4) there are many of the points that commend the physical exercise of football. Extreme skill, delicacy, cleverness, and quick wit, added to the general muscular training, make the game one of the best of exercises and one of the most beautiful sports known. Lacrosse

can be played also by many men who find football too severe; but it is nevertheless a fact that with the disappearance of the personal-contact feature in football there goes some of the muscular training about the shoulders, chest, and back. Lacrosse develops the leg, side, and abdominal muscles; but if a player in good training will spar for half an hour with a boxing teacher he will find the next day that all around the upper part of his body the muscles are stiff and lame, which is a proof of the fact that in his lacrosse he has had no use for some of these, and that they are consequently not being devel-

Lacrosse.

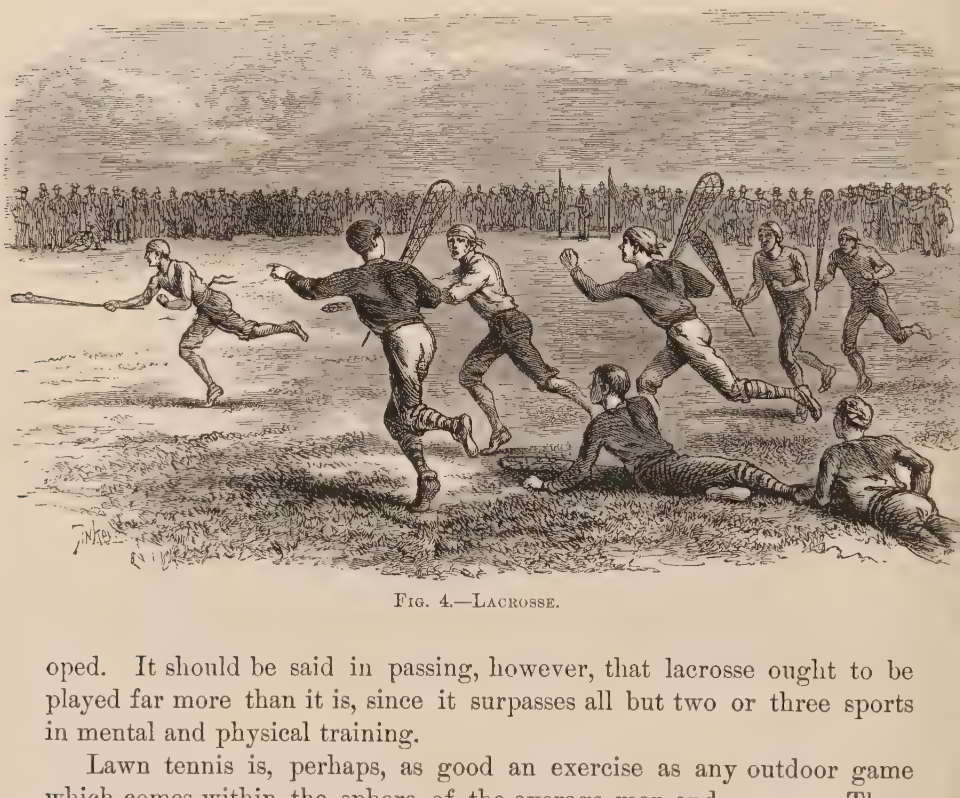


Fig. 4.—Lacrosse.

oped. It should be said in passing, however, that lacrosse ought to be played far more than it is, since it surpasses all but two or three sports in mental and physical training.

Lawn tennis is, perhaps, as good an exercise as any outdoor game which comes within the sphere of the average man and woman. Theoretically the game requires a perfectly level turf of rather extensive proportion, which is impossible for most people to procure; but practically any group of persons, in town or country, may, by clubbing together, form a tennis club at a cost of but a few dollars a year apiece. The game requires little time, and is feasible for seven or eight months of the year out of doors, and for the whole year if during the winter it be played under cover. A moment's consideration will show, however, that tennis has not the merits of any of the

Lawn Tennis.

foregoing games as an exercise. In the first place, it develops the right side at the expense of the left. In the second place, there is no personal contact, which, while it always makes a sport more dangerous, gives a greater variety of exercise to the muscles and introduces qualities of mental training that are totally wanting in tennis. At the same time and for this very reason tennis is more practicable, less exhausting, and therefore includes among its players men and women of all ages. For a business man, who can get a good half hour of tennis each evening after his work, there is scarcely a better or more feasible exercise when all things are considered. The playing of men and women together is distinctly a mistake, of which more is said hereafter.

It may be as well to note here that no game should be taken up superficially. If exercise is worth undertaking at all, it is worth undertaking seriously. The player should always do his best. If he is tired out he should stop; for ten minutes of tennis or anything else when you are in a wearied condition will do a definite amount of harm. One should invariably prepare for his game in costume, should play with study and care, should never sit about after stopping without carefully wrapping up, and should invariably bathe in hot and then cold water as soon as possible after stopping, for these are the laws of the athlete to the ends of the earth, and the manner in which games are played is far more important than the games themselves.

Baseball.

Baseball as an exercise is peculiar. There are certain points about it that make it valuable both as a mind and body trainer, but it is more of a game than an exercise. The sudden movements, the sometimes protracted periods of inaction, with the consequent nerve tension, make an otherwise admirable sport for the young and middle-aged only a secondary exercise in physical training. The real value of such a game is in the training it gives one while he is preparing for it. And here again is a proper moment to urge old and young who take up such a game to play it systematically. The ordinary "knock up," or "scrub," or desultory choosing of sides, have no trace of physical training in them, except the fact that the players are in the open air. To make baseball beneficial the nine should be carefully chosen, each man studying his position, regular practice being taken each day and games played periodically. With all the accompanying rules, such as dressing properly, bathing after practice, and eating carefully, the hour of exercise is of course beneficial. When all is said, however, baseball is not as complete an exercise as any of the games that have already been mentioned.

Cricket is as yet hardly an American game, but in general the same may be said of it as of baseball. It is a good sport if systematically kept up, but there is an amount of sameness to it, a lack of general develop-

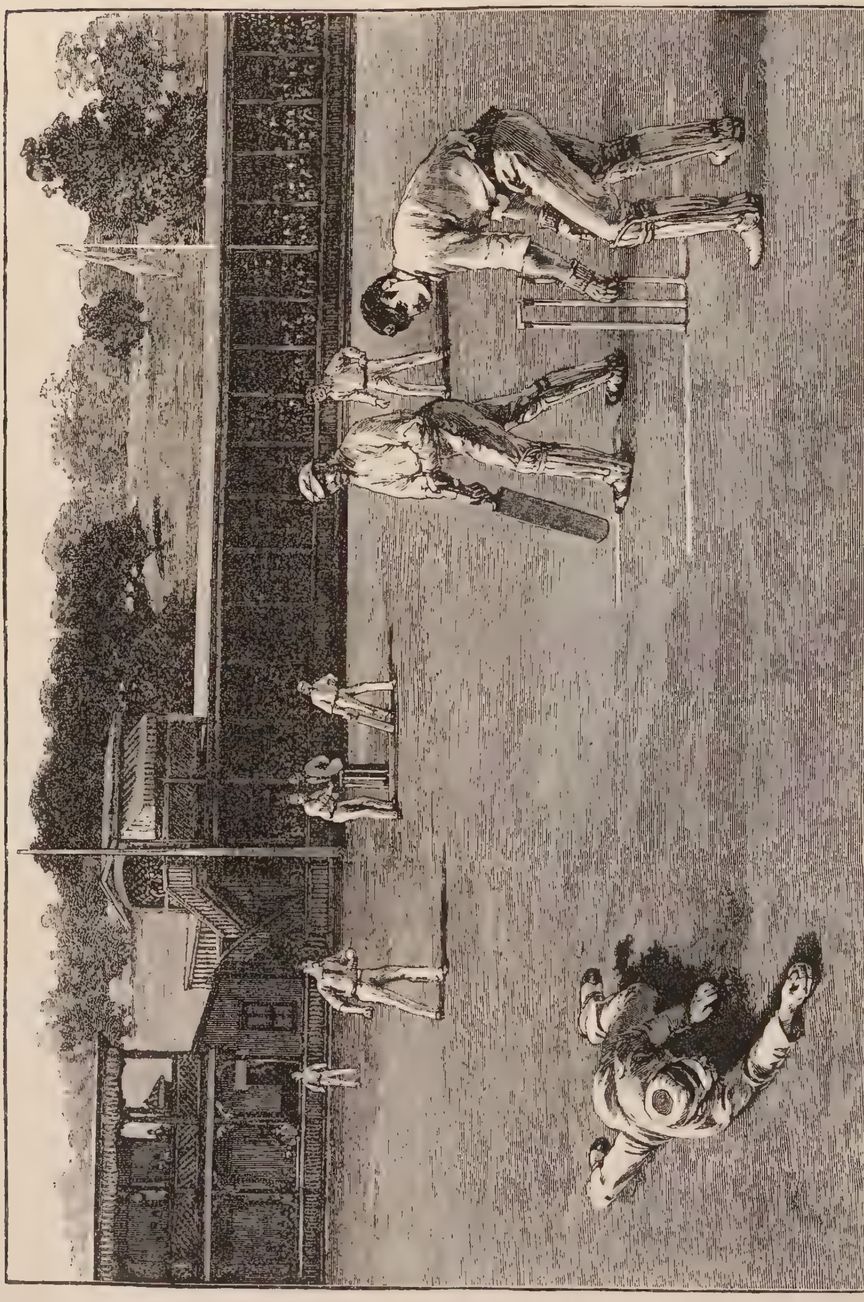


Fig. 5.—View of a Cricket Crease with the Game going on.

ment in the exercise that makes it hardly a game to be undertaken as a means of accomplishing physical culture, though both these games as games have few equals. As in baseball, one should always avoid the desultory, unsystematic game. Cricket requires eleven men to a side, and there can be no real game unless twenty-two men are at hand. Without the complete number the game is weak, no systematic team play can be put into it, and the players get none of the mental good to be obtained from it. With the full number, however, there are few games where more skill is involved. The bowler has an infinite variety in his work, and the chance for individuality is extraordinary. So also in the case of the batsmen. With a full field they have to judge the ball and at the same time pick out a hole in the field where they may send it, and, finally, they have to know the use of the bat so well that they can direct the ball to within a few feet of the spot at which they aim (Fig. 5). All this involves study long and thorough, and all this is lost in desultory, half-hearted games, while bad habits are easily learned.

Cricket.

The disadvantages of football, baseball, and all such games are, however, present in cricket also—namely, so many men are required that it is not every one who can bring so many men together and get daily practice in the game.

Golf has been recently introduced into America from England and Scotland. The enthusiasm which has characterized its devotees is a sign of its merits. Like cross-country riding, it was generally considered an English fad, and very likely some attempt at aping the English was the cause of its introduction here. But the game has merits that few other sports can present, and for this reason it is worthy of careful attention as an exercise. In the first place, golf can be played by both men and women as well as by boys and girls. A boy of fifteen and his grandfather may play it and neither give the other a handicap. At the same time that the club swinging (Fig. 6) is an admirable exercise for most of the muscles of the body, the game has none of the drawbacks that come from sudden movement. The whole course of the sport is steady yet vigorous, and it

Golf.

Fig. 6.—Golf: act of driving.

can be played for nine months in the year in the northern part of the United States and for the entire year in the South. The expense is light after the links are laid, and these can be prepared, after the organization of a club, anywhere in the country that there are open fields. For business men in middle and old age and for their wives there can scarcely be found a better outdoor sport, and the amount of interest and skill connected with the game are almost infinite.

In England the game is much better understood than in America, and a practice has grown up in the former country which might well be adopted in the United States in connection with golf. This is that frequently in Scotland and in England business men take an hour and a half to two hours and a half at lunch time. They not only get lunch, but they have time to go the rounds of the links once perhaps, and come back to work braced for the rest of the day. This could not be done, of course, by a man out of training without tiring him so thoroughly as to make his afternoon work useless; but in a short time he learns to come back to his work ready to cover twice as much as before. This practice of taking a long noon hour and working later at night is an admirable one, and it would do Americans a great deal of good if they could break away thus entirely from business in the middle of the day. Such a respite has an extraordinary influence in quieting nervous temperaments, and relieves the muscles and starts the blood just when both are growing dull and sluggish.

Ice Sports.

Ice sports, including skating pure and simple, as well as games played upon the ice, such as hockey and ice polo, are natural and healthy kinds of amusement out of doors. In a large portion of the United States, however, they are impracticable, or nearly so, since the climate is not cold enough to furnish the ice. They do not, therefore, play an important part in physical training. Their great use is in supplementing some other sport that has been kept up for ten months of the year and, perforce, dropped on the first fall of snow. Ice sports, too, except straight-away skating, are confined largely to boys and young men.

Track Athletics.

Track athletics, which include long-distance and short-distance running, high and broad jumping, hurdle-racing, hammer-throwing, and shot-putting, are sports that require more care from an instructor than any of the games already mentioned, so far as purely athletic exercise is concerned, for in long-distance and short-distance running, for example, one may do himself far more injury than good, unless he runs in the proper way. The same is true of the other track-athletic sports mentioned. Running is neither easy nor healthful unless undertaken in the right way; 100- (Fig. 7), 220-, or 440-yard dashes should never be undertaken suddenly, practice being required before the

lungs and heart are rendered capable of undergoing the strain. But, on the other hand, steady training of the right sort for these events is an admirable method of preserving health. In long-distance running—that is, from two to ten miles—the runner, dressed in suitable light costume, should begin with five-minute "jogs." These short runs may be extended, as days go by, to ten-, fifteen-, and twenty-minute runs, two weeks being given to each period. In time this can be extended again, until the runner can easily keep up a slow run for one or two hours without undergoing any greater strain than he sustains in the first five-minute run. It is this steady preparation in all track athletics which, if carried out in the right

FIG. 7.—ONE HUNDRED YARD DASH.

way, makes healthy muscles and good spirits; for at the same time that one prepares oneself properly for a contest, one prepares oneself also for a healthy body. The value, then, of track athletics is in the daily hour of practice for some event, not in the event itself; and hence that hour of practice should be maintained religiously as long as the weather permits. Indeed, if the practice could be maintained without the contest, it would be fully as well for the health of the athlete, since hard-fought contests are in themselves apt to be injurious.

Rowing, when studied as it is in the colleges, or in singles, pair oars, four, six, or eight oars (Fig. 8), is a questionable exercise. It has its merits, of course, and they are well known; but it is certain that four-mile races, such as those rowed between the American and English universities, are

injurious, for the reason that they not only overtax the heart and lungs, but prove too great a strain on a man's nerves. Aside from the question of contest, however, rowing is a doubtful means for physical training. It only brings into play certain muscles. It develops these at the expense of others, and the very merit of it—the precision and absolute repetition of stroke after stroke—renders it too precise, too unvaried and methodical to be a perfect physical exercise. We have all seen many an example of this. I remember a rowing man in perfect training making the attempt to play a game of polo. He found himself the next day as lame as any one would have been who had taken no exercise for a long time. On the other hand, no one ever knew a polo player or a football man in good condition to be lame in any way after a day of rowing. In other words, these two games exercise every muscle alike, while rowing gives practice only to a chosen few.

Rowing.

Fig. 8.—Rowing: eight oars.

From this short consideration of the more important outdoor sports—which unfortunately, for obvious reasons, can not be more extended and thorough—it will be seen that no game is a perfect physical exercise and at the same time open to old and young of both sexes; and indeed there are drawbacks to all from the theoretical point of view. It is for this reason that so many people have grown into the error of recommending special-development exercises as better for the average person. This is a false theory for many reasons. There are bad points about all sports, but sports put vitality and spirit into the man or woman who takes them up, and they afford something that is never supplied to a man by years of practice on the pulley weights. They bring into play the mind, the brain, and the qualities of courage, self-reliance, and confidence which are totally absent from all special-development exercises, but which have more to do in making a healthy mind and body than any amount of large muscles. Furthermore, though match games, races, and prize contests are, as a rule, not advisable from the trainer's point of view, they are tolerated, so to

speak, for the good they do in stimulating a man to train long and faithfully in preparation for them and in educating by the force of example the desire for athletic prominence among others. With all their faults, then, games, rather than special exercises, should be chosen as the medium for securing and keeping physical health, wherever and whenever any one of them is feasible.

There are, however, men and women who, for many reasons, can not, or believe they can not, take up any game systematically, and for these special exercises are the only, and therefore the important, subjects to study.

OUTDOOR SPECIAL-DEVELOPMENT EXERCISES.

The whole question of exercise is, in other words, one of degree. Every one should take some exercise. A law should therefore be laid down setting forth what are the best methods and what the best forms for exercise. This being done, it is the business of the individual to fit one of these methods or forms to his particular circumstances. Finding none of these available, it is his physical obligation to himself to turn the printed page of physical training and find some plan which, though less useful in theory, does suit itself to his surroundings. If no game is feasible, then he should undertake some special exercise. It does not alter the fact that outdoor games are the best educators of health, that they are better than meaningless exercise; yet, at the same time, it does not mean that there is no good to be attained from this second form in athletic training. The outdoor special training is thus better than the third or fourth page—that is, indoor games and special exercises—just as they are better than no exercise at all.

Overeating and Lack of Exercise.

For one reason or another, therefore, games may not be open to the individual in question. His entire day may be taken up with work, and hence the night is the only time when his exercise can find a place. The question that confronts him is, Does it behoove him to exercise some particular part of his body, or should he merely try to keep an already healthy frame in working order? That is, should his outdoor work be special or general in its form? In most cases it is the general that is needed. Men of the city, of the town, and often of the country, as a rule eat too much and take too little exercise. If the body is reasonably healthy its possessor has a large appetite, he enjoys his food, and he does himself no apparent injury by eating three good meals a day. If there is little or no time for athletics he gives no attention to them. The result is that several times a year he has throat trouble, or perhaps once a month he comes home from work and goes to bed with a bad headache. His wife or mother very

likely sends for a doctor. Next day he begins work again, a little weaker perhaps, but still not ill enough to be sick in bed, and in a week the large appetite has returned.

I venture to say that this is the history of most men and women in the United States who are, to all appearances, perfectly well. Much of it is due to overeating and lack of exercise, and any one who stops a moment to think of it will confess that to overload a machine like the human body and then not keep it working will clog it, set all its parts by the ears, and then, as the strain grows greater, some little portion of the mechanism will break—that portion, of course, which may be naturally weak or have a flaw in it. Hence, if your throat is naturally sensitive, you have a cold which requires a physician's care. The most glaring example of this that has come to my attention, and which in its *dénouement* would have been comical if the whole history of it had not been sad, was of a man who suddenly found himself afflicted with heart disease. He could not walk. He could not go up a flight of stairs. He was treated for heart disease of a certain kind, because he had once, ten years before, been troubled with the working of the valves of his heart. Day by day he grew worse, until finally a shrewd physician stopped his eating anything but meats, and ordered him to drink hot water. The third day afterward he went upstairs for the first time in months. In four weeks he was nearly as well as ever, and now, instead of weighing two hundred and twenty-five pounds, he weighs one hundred and eighty, takes some regular exercise daily, and eats carefully and lightly. The history of it was that he liked good food, ate heartily, took no exercise, clogged the machine given into his charge, and the one point in his mechanism that had a flaw in it—the heart—gave way for the time being, fortunately not so completely that it could not be repaired, when the whole machine was running smoothly again. Outdoor special exercise, or, in fact, any exercise, will to a certain extent lessen the tendency to overeating, though the eating should always be kept under careful control.

One of the best means for general muscular exercise, and especially so because it can be practised at night as well as in the day, is walking.

Walking.

Walking is one of the most abused exercises known to man. Undertaken in the correct way, it affords capital physical training, and, as far as it goes, as good as any. It does not equal any of the sports already mentioned, because walking can be undertaken without forcing the mind to drop the work of the day. Theoretically, walking requires a great deal of mental attention. Practically, one may brood over the troubles of the day while trudging along a road, and if the gait is steady and the movement solid and heavy, the walker may return home after an hour and not have received any more exercise, except to his lungs perhaps, than if he had stayed at home. Once carefully

studied, on the other hand, walking turns out to be a difficult matter. There is a distinct position of the body for it, and any one who decides to take it up as the only half hour of physical training open to him, should learn this correct position and always take it. In the first place, he should dress for walking, wearing light clothing, no suspenders; if on a track, nothing but light walking shoes, short cotton walking trousers, and a light flannel shirt; if through the streets and in the country, an ordinary suit, large, loose, flat-heeled shoes, and a felt hat. The shoulders should be thrown back, head a little forward and chest out, the arms bent a little at the elbow, the fists clinched, and a vigorous movement of the shoulders developed, which not only carries the body in a long stride, but enlarges the chest, shoulder, and back muscles. The stride should be long, steady, and quick, and made from the shoulder and hip, not from the knee alone. This can be acquired by rising on the toes of the right foot, leaning forward, and at the same time swinging the left hip forward—partially turning to the right, in other words. Then, placing the left foot upon the ground as far in advance as possible, the whole body should be swung forward until the right hip and shoulder are in a like manner advanced and turned a little to the left. While this adds to the length of the stride, and brings all the side muscles into play, it gives opportunity for the pulling-back movement and thrusts the body forward with a quick, vigorous action that adds springiness and vitality to the exercise. The step itself involves the rising upon the toes of each foot alternately to their fullest extent, each step ending in a vigorous spring from the ball of the foot. The foot itself should point directly forward, being neither "turned out" nor "in," in other words. A four- or five-mile walk of this sort each afternoon before sundown is an admirable, inexpensive, and, for most people, a feasible exercise, and not the least of its good points is that it can be undertaken every day in the week. Nevertheless, it must be remembered that it lacks mental exercise and relaxation for the brain.

Riding.

Riding has the great merit over walking that it does furnish this relaxation for the mind. That relaxation is the companionship of the horse, which requires the attention of his rider to such a degree that it is at least easily possible to find rest and change of thought thereby. For any one who is so situated that he is either in or can get into the country for a half hour or an hour a day, riding is a capital trainer, especially riding to hounds. Riding after hounds is increasing in the United States, and it is a mistake to believe that the sport must be confined to the wealthy and the aristocratic. Any dozen persons in a town can easily secure a few hounds who will follow the scent of an aniseed bag if foxes are not to be had; and, indeed, hounds are not necessary so far as the exercise is concerned, for one may

lay out a cross-country course for his run and follow that as well without hounds as with them. The exercise given the muscles during such a ride is general, and for that reason alone it is valuable.

Swimming.

In the heat of the summer walking and riding can hardly be supplemented by a better all-round general exercise than swimming (Fig. 9). In swimming, however, as in all other exercises, there is one correct and many incorrect ways. There should be no desultory paddling about, no occasional sea bath once or twice a week, but a systematic plan involving a short swim each day. The particular man or woman who is near the seashore and takes up swimming for the hour's daily physical training through June, July, August, and September, should choose the most suitable time of day for it and then keep to that same hour each day through the four months. Often before breakfast is a good time, or late in the afternoon, before supper or dinner. The body should be cool before going into the water, and the stomach should not be occupied in digesting food—that is, the man should have eaten at least two hours before bathing. If possible, swim without bathing clothes of any kind. Once cooled off, go down to a pier and plunge into the water by diving head foremost. Thus the blood in the head receives the first shock. Come to the surface and swim directly for some definite point as far away as your capacity for swimming will allow. Never swim, however, after you become aware of a feeling of weariness and exhaustion. A swimmer may be out of breath and not tired. Hard breathing is not in itself a bad thing. It shows that the lungs are being distended and exercised. Having reached the desired point, swim back with long, slow, complete strokes to the pier, come out of the water at once, rub yourself thoroughly, and dress. Afterward sit or lie quietly for from fifteen minutes to half an hour. During the course of this swim, which can be extended as the powers of endurance increase, every

FIG. 9.—SWIMMING: PROPER POSITION.

conceivable muscle of the body is used, and four months of such work will make your daily duties easier than ever before.

Bicycling.

We now come to an important exercise that requires special attention. Bicycling can be enjoyed so easily at any time of the day or night, and the expense is relatively so small, that the bicycle is becoming extremely popular for both sexes and all ages. And there is much in it that is good. It is distinctly an error, however, to ride a bicycle too frequently, or too much at one time, or at any and all times of the day and night, especially if physical training is one of the reasons for riding. Here, as elsewhere, a regular scheme for each day's exercise should be followed. There should be the half hour, or hour, of steady long-distance riding, and the fifteen minutes, or half hour, of speeding at its close. Care should be taken as to costume, as to the bath and rub-down immediately after the return, but more especially as to the correct way to ride. There is no necessity for the wheelman to bend over the handles (Fig. 10). This compresses the lungs, strains the back, and not only develops what are called "round shoulders," but slowly and surely displaces the chest and abdominal muscles in a way that is sure to produce ill health in time. The constant jar in riding is also an injury to the liver and other parts of the body. To avoid this as far as possible, the rider should never allow his muscles to become rigid. For example, when a bicyclist becomes a little wearied he will straighten his arms, thrust his chest forward, and allow his shoulders to be pushed backward until the shoulder blades almost touch each

Fig. 10.—Bicycling: incorrect position.

Fig. 11.—Bicycling: correct position.

other behind him. His neck will protrude and he will sway from side to side on each pedal in turn, sending the machine with the weight of his body instead of the force of his muscles. If you ever get into this position as a result of weariness, the only thing to do is to dismount and rest until the weariness has in a measure disappeared. But no rider should ever allow himself to get into such a position. In the first place, it is actually injurious, and in the second, it renders the exercise without merit as a physical trainer. The proper position is to sit erect with the arms a little bent to allow some spring, with the legs moving at thigh, knee, and ankle with each revolution, and with the whole body upright and stationary to avoid swaying from side to side (Fig. 11.). When this position cannot be maintained it is time to stop.

Outdoor Exercises not Games.

I might go on bringing out the points in other similar outdoor exercises that are general in their nature and yet are not games in the strictest sense, but this is sufficient to suggest to the readers who really wish to take up some exercise, the good as well as some of the drawbacks of such forms. They will soon find many other sports like these if they care to search for them. None of them are as good as games, but they have one great merit over special-development exercises—*i. e.*, that they do not exercise the same muscles in precisely the same way all the time. Walking uphill is quite different from walking downhill, as any one will soon learn who tries both; and walking along a level road is neither of these two. In like manner, riding, jumping, and running a horse are all different one from another; swimming on the stomach, on the side, on the back, employ each its own set of muscles, or rather all the muscles in a different way. These or other exercises should be taken by every one throughout the year day by day, the object being to preserve health by furnishing something in contrast to the regular occupation of the individual.

There are, however, certain occupations which, involving as they do the use of certain muscles at the expense of all others, or requiring that the body be held in more or less cramped positions each day, make it necessary that the other muscles of the body be given a superabundance of exercise to make them equal these and keep the body normal. Furthermore, many persons are chronically weak in one portion of the body or another. Their legs are strong while their chest muscles and shoulder muscles are weak, or both may be vigorous at the expense of the abdominal muscles. Exercises tending to correct these inequalities are available at every turn, but it should be invariably kept in mind that all special-development training is to be carried on in the open air if possible, and in the daytime as well. If daylight is impossible, they should be undertaken at night, but still out of doors, and finally, if not out of doors, then under cover, but in the vicinity of open windows and doors.

I remember the case of an individual who does not live a hundred miles from New York. His life was a sedentary one, and he was compelled to sit at a desk during the hours of the day. Outdoor games were for the moment therefore not to be considered. Yet he found his leg muscles growing so weak and his lungs so out of condition that he had difficulty in going up four flights of stairs. The chief difficulty was with the muscles of the calf, the thigh, and the back thigh. Finally, he hit upon the following plan, and this happened to be in the winter too: Immediately upon arriving, at six o'clock, at his home in the suburbs of New York, he went to his room and stripped. Then he put on "sneakers," a pair of cotton drawers cut off at the knee, and an undershirt not only without sleeves, but with most of the shoulder cut out. Over this he wore what is called a "sweater." This was all his clothing. He then went out on to a long, straight road, which was not much used at night, and began to trot slowly along through the three inches of snow. He had studied how to run. His shoulders were thrown far back, his arms swung across his chest in a bent position, each hand grasping a large piece of cork cut in the shape of a banana. His chest was thrown painfully (at first) forward and his head back, so that he could look up at an angle of about thirty degrees. His abdomen was thrown far forward and his back bent in. He ran on his toes, never letting his heels touch the ground. In three minutes he was not only perspiring freely, but he had to stop from sheer muscular exhaustion. Realizing that he must not stand in the cold, he turned and ran back. The whole time was not over ten minutes from the start to the moment when he got into a bath of lukewarm water. This was followed by a cold-water sponge, and then, rubbing his skin with a hard towel, he dressed, and was sitting at dinner at a quarter before seven, and found himself struggling not to eat too much.

Special Exercises for the Legs.

For a man of almost any age who can not play a game in the daylight I know of no better exercise if his occupation involves desk work. The chief good of it is in the muscles of the legs—by running on the toes. If the heels are allowed to touch, neither the muscles of the calves nor of the thighs are effectively used. The lungs received as complete an exercise in their way as the leg muscles, simply from the position in which the shoulders were held and the long, deep breathing that was necessary.

There are many such exercises within the reach of every one. Broad or high jumping, which can be carried on in the back yard of any suburban or country house; hammer-throwing, shot-putting, or high kicking, and many others that will naturally suggest themselves.

For the waist and abdominal muscles there are several of the more common athletic sports that are admirable exercise, all of which can be adapted to the use of a single man in or near his house and without the

need of much preparation or expense. There is hardly a better movement to bring in the side muscles—in fact, all the muscles about the waist —than throwing the hammer (Fig. 12) and putting the shot (Fig. 13). One needs but to swing around the head at arms' length a sixteen-pound shot attached to the end of a pole three and a half feet long a dozen times to find this out. Any open lot with a hundred feet clear is suitable for these exercises. The former should be treated gingerly at first, as should shot-putting with a sixteen-pound shot, for the strain to unaccustomed muscles is prodigious. The swinging of a hammer and the practice in the movement required in the putting of the shot should be carefully studied at first, attempts at record throwing not being taken into account at all. Between five and six o'clock at night, or early in the morning, half a dozen careful "throws" or "puts" should be made, and then some other general-development exercise taken. As time goes on the number of throws should be increased, and if the movements are correctly made the number is not to be limited except by the feeling of weariness, which is the telltale of what a man can do and the signal for stopping the work for the time being. Six puts and throws a day are better than a thousand once a week. Other exercises there are and their name is legion, but we can only suggest the principal here and leave the individual to find what is best suited to his needs. If he is anxious to find it, there are hosts of books to tell him where and how to search. And if he feels Necessity urging him on to exercise, that maternal parent will set her child at work to invent a way for himself.

Waist and Abdominal Muscles.

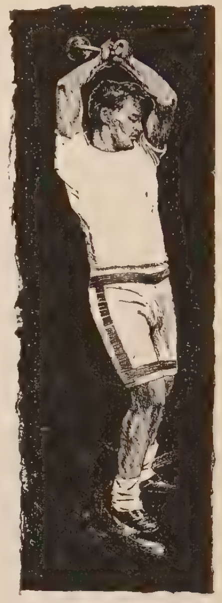


Fig. 12.—Throwing the hammer.

Fig. 13.—Putting the shot.

For the shoulders, chest and back muscles such exercises as tree-chopping are the kinds needed. Here, again, however, there is one right and many wrong ways. Chopping to be really effective must be studied carefully. The chopper should stand a short distance from the tree and strike so that the blade will enter the trunk at a height from the ground

a little greater than his own waist. At the end of a stroke, with the blade sticking fast in the tree, the chopper stands erect on both feet, knees and heels a little apart, head up and shoulders back as far as possible. As he swings around on his right side the knees should bend, the whole body sway, and the whole physical system, especially shoulders, chest, and upper back, be brought up with a quick, strong movement. Having given the right side of the tree a dozen steady strokes, stand in the same position and follow this with another dozen on the left side. Never fall into the error of thinking that you are getting proper exercise by chopping always on one side, and do not worry too much about cutting the tree down. That is a minor point. Splitting wood that lies upon the ground is another good movement, bringing the back muscles into effective use.

The Shoulders, Chest, and Back.

For the arm muscles, the biceps, the triceps, and those of the forearm and hand, ordinary rowing such as a man or boy may get if he lives near the sea or a river in an ordinary rowboat, is effective. This rowing is not the same as the training of an eight-oar boat. It is the individual pulling of one man who does not use his back as much as a professional, who sits upright and pulls with his forearm and biceps, grasps the oar firmly with the hand, slackening the hold a little with each stroke, and throwing the oar back on the recover with his triceps. All these motions should be complete, steady, and strong, stretching and contracting the muscles in turn to their utmost extent, a necessary part in all effective muscular exercises. This was well illustrated once by a famous trainer in speaking of some of the chest, shoulder, and arm movements in rowing as being like what is called stretching, meaning the motions which a man makes after sitting or lying in one position a long time. "In fact," said he, "stretching is nothing more than an involuntary attempt of the muscles to exercise themselves." It is for this reason that slow walking, running on the heels, rowing in short, unperfected fashion are not good.

The Muscles of the Arm.

It is health which we should strive after. Many a trainer has made the mistake of thinking that his pupils were striving for large muscles or the ability to excel in some particular branch of sport. For those who do look toward one of these accomplishments this article will have no interest, for its writer neither believes in the importance of their objects nor that health is insured or induced by them. The highest accomplishment of physical exercise is to make a healthy and symmetrical body. It may be well, therefore, in this connection, to suggest in a few words the best outdoor exercises likely to produce this symmetrical body in the case, first of a man, then of a woman, and finally of a boy and girl.

SPECIAL OUTDOOR TRAINING FOR MEN.

The average American is pretty badly off so far as a normal condition of muscular development is concerned. In the first place, a man of forty in America, as a rule, has not exercised the muscles of the lower part of his body sufficiently. He is undeveloped below the waist. Furthermore, the same American is more than apt to be one-sided above the waist, and round-shouldered besides. The reason for this is that in the United States men work too long and too hard from day to day, and do not think of physical exercise as a part of their labours. It is safe, therefore, to give the following suggestions for the guidance of the average man from thirty to sixty years of age. What athletic work he does—and he has little time for it—must be to counteract desk work and lack of movement on the feet. It should be as vigorous as he can stand, and must be discontinued the moment it becomes wearisome. It should be vigorous enough to produce a normal amount of jar to the body and stimulus to the blood in a day and offset the long hours of sedentary work. The exercise must be a little greater than natural steady movement would furnish, in order to make a general average at the end of the day.

In Middle Age.

If possible, the man should play something like polo twice a week. If that is, however, impossible for lack of time, of money, or of physique, lawn tennis, played for a short time daily, should be the next in order. Dress for the sport and play every afternoon from one half to three quarters of an hour—at most an hour—from the middle of May into November. From the middle of November to May, either play tennis indoors, or, when feasible, hockey, ice games, or something equally vigorous, for the same length of time and at the same time each day. If it is impossible to do this except on Saturdays and Sundays, play tennis an hour or more (always depending on the feeling of weariness) on these two days during the summer half of the year, and on the evenings of the other days of the week get the same amount of exercise by running at first half a mile each evening, gradually increasing this to three or four miles. In the winter play an ice game on Saturdays and Sundays and on the other evenings run or skate or take some equally vigorous exercise. This may, and very likely does, seem impossible to most men between the ages named, but it is astonishing how much work can be done and how regularly, if the individual really tries to do it.

It would be a mistake to try to replace tennis by rowing as a daily exercise. Rowing can not be beneficially so undertaken. Bicycling is good in its way, but not equal to tennis. It is too precise, too little of a

really stirring exercise greatly to benefit either mind or body, and there is some question whether bicycling is not likely to be injurious. Bicycling, however, is a good example of what a man can do in the way of exercise if he makes up his mind to it, for there are many who would say that it was impossible for them to find time for running or for tennis who, nevertheless, spend the same amount of time in wheeling. In other words, one can usually find time for what he really wants to do. Yet, if tennis is impossible, fall back on bicycling, always remembering to finish the ride with a reasonably long and hearty spurt, followed by a bath and rub down. If in winter, ice exercise, running out of doors, and all other such exercises are impossible—but only then—fall back on indoor or gymnasium exercises. Finally, remember that for men from thirty to sixty years of age, unless they are in the best of condition, violent games are a mistake. The change from the sedentary hours of the day is very sudden for any one over forty, and is rather dangerous.

In Old Age.

For men approaching sixty the nightly run may be, to all intents and purposes, impossible. Tennis is also slowly creeping beyond their reach, and they will say to you, perhaps, that all games are too vigorous for them. This is not so. Easily within their reach is golf, which, while it is capital physical training, and not less to the lungs than to the muscles, is also a sport that admits playing by men of sixty—even seventy—while the preparation for it is simple enough, provided the open country is at hand. Nowadays almost every city has its golf clubs in the suburbs, where for reasonably small amounts a man may have plenty of opportunity to play. Apart from games, there are many general exercises, such as wood-chopping or tree-chopping, riding, or walking. I have seen many men working in gymnasiums under the impression that they were doing the best possible for themselves physically, when half the time spent in cutting down a large tree or taking some outdoor exercise would do them much more good.

SPECIAL OUTDOOR EXERCISES FOR WOMEN.

As men's exercise in general should be to counteract office work, so women's exercise should be to counteract housework. In general, therefore, the object in view should be to practise something involving agility, without too sudden or too vigorous movements. The same general principle of light but regular and periodic exercise should be borne in mind and followed to the letter. *It is of the utmost importance that women should remember to stop exercising, whether at games or special-development movements, the moment they feel the slightest weariness or strain growing upon them.* One of the best games for them is golf; important

here, as in the case of men, because it can be played fast or slow, and the amount of exercise thus graded to suit the player. But it still remains an exercise which is, in its way, as good sport as any to be had, and which calls for a great deal of skill and attention.

Fig. 14.—A woman playing golf.

Golf and Tennis.

Golf (Fig. 14) is open to women of almost all ages, while tennis is confined to the young and middle-aged. There is, too, a danger in tennis that one may play too long, forgetting the feeling of weariness in the excitement of the sport. If it is begun lightly, however, and played with a certain amount of coolness and attention to labour-saving, there is no finer outdoor game for women. It would be far better if the costume could be arranged in accordance with the needs of the game, for much energy which is now spent in managing the skirts might be put to better use if the player wore bloomers. It must, however, be borne in mind that women should never play tennis with men. There is more of the athlete in a man, and the woman

naturally tries to compete with him when playing the game. This causes an unnatural exertion on the part of the woman, and the result is that the exercise is overdone.

Walking and Skating.

Walking and skating, especially straight-away skating, a little each day, are both admirable physical training for women if the rules for these exercises already laid down are upheld. A mountain tramp of from four to five hundred miles in the summer, taken during an outing of eight or ten weeks, stores up an amount of health in a woman that will carry her through the rest of the year. But to gain physical health when the individual does not possess it, ten weeks is not enough. She should make it her business to be out of doors at least one hour a day throughout the year, doing something in which physical exercise and training bear an important part. Golf or tennis for a good part of the year, with walking (not less than three miles at a time) interspersed, with skating in the winter—any one of these, carried out theoretically, is sufficient not only to keep a person well, but to restore to normal condition many bodies that are sadly in need of restoration at the start.

Riding.

Then come the three doubtful exercises for women—much-vexed questions: riding, rowing, and bicycling. There are certainly good points in all these, but at the same time there are bad ones. If any or all of them should prove to do you no harm after a generous trial, there is probably no reason why you should not keep them up in moderation. But they are all, in a measure, ill-advised. Riding, bicycling, or rowing may be carried on temperately, but the limit for a woman is usually less than that for a man, and it varies more among women than among men. Each girl and each woman should, therefore, either have the advice of some one competent to give it on these subjects, or she should study herself to learn what her capacity is in any one of these exercises she takes up. It should be borne carefully in mind that the best horse for a woman is the one with the smoothest motion, that the rider should use a three-pommel saddle, and should avoid, as far as possible, trying to make the lower part of the body move absolutely in unison with the horse, while from the waist up she allows herself to swing backward and forward. This is a common fault, and it is committed through an almost involuntary tension of the muscles of the legs against the pommels. It not only causes weariness from long tension, but swings the upper part of the body about in a way that is enough to wrench all the muscles of the abdomen and lower back. Riding, in the case of women, should therefore be studied first, and then, when the equestrienne can sit with all her muscles relaxed and keep on her horse by balancing herself with the reins (her feet and the pommels being thrown out of the question), she may begin to think of it as a suitable

form of training to undertake systematically if the vigorous exercise is not too severe for her particular case.

Bicycling and Rowing.

In the same way bicycling and rowing have their bad points, more especially the former. Women should have wide, flat saddles to their bicycles and should sit on them in an upright position, merely using the handles for steering, as I have already explained (Fig. 15). Furthermore, they should never ride with men more than ten miles. In fact, it is safe to say that, as a rule, men and women should not ride together, since a man naturally takes faster and more vigorous exercise, and thus stimulates the woman to equal him, and paves the way for her to injure herself, and the same may be said of rowing.

Fig. 15.—Bicycling: correct position for a woman.

Indeed, the exercise of women might well fill a volume by itself. It is most important and is most frequently passed over. Hardly a work on physical training mentions women's exercises, much less considers them carefully, and yet the grace, ease, and physical bearing which make a woman not only healthy, but attractive to both her own and the other sex, all lie in the hand of physical training. Steady, light, not too vigorous, but supple and general exercise—that is what is needed. Costumes, too, play an important part, and when exercising, when walking, playing tennis or golf, women should wear no stays, and should avoid, as far as possible, any skirts. Fortunately this is now being recognised here and there, and in time the whole question of women's exercise is sure to receive the attention it deserves.

OUTDOOR EXERCISES FOR GIRLS.

No society girl, no farm girl, no girl of the office or factory, the shop, or the home, should be without some daily outdoor exercise, a game —and that one involving exercise most in contrast to her ordinary life— being the best form in which to take it. In general, what has been said of women's exercise applies to girls, though the latter can and should take much more of it. They may also enter into somewhat more vigorous games. They ought always to avoid sports involving personal contact, however, for such sports tend to wrench the frame too much to admit of girls indulging in them. Tennis, riding, golf, skating, bicycling, croquet, in a moderate way running and rowing—all are as suitable for girls as boys, and yet all, if not practised in the correct way, may become injurious.

OUTDOOR EXERCISES FOR BOYS.

The physical training of boys is perhaps the most important part of this large subject. Unfortunately, it can only be suggested to parents here how important a part of their son's life manly physical training is. If a boy is kept well at physical exercise until he arrives at manhood, not only will he be so well and healthy physically as not to need the care of doctors, but he will have formed the habit of treating his body with care; he will have his full share of common sense, reasonable confidence in himself, and a moral and physical nature that will carry him safely over many a hard road. There should be in every school—and fortunately there is in many already—a compulsory course in regular physical training; not only wooden dumb-bell work, but honest, thoroughbred, outdoor games. If you chance to visit a school where the head master or the assistants go out during recesses and play baseball, football, cricket, and all the other games with the scholars, you are likely to find not only vigorous bodies all around you, but a healthful spirit of good-fellowship between master and pupil, and a high standard of scholarship and dignity pervading the whole school.

Importance of Organized Games.

The importance of games to boys is almost beyond measure. In their sports organization plays an important part. They should take up games involving "sides," each including several individuals. The object of this is that the players secure a more comprehensive physical training, and at the same time learn what organization, subordination, authority, and system mean. For grown men this is neither necessary nor always possible; but for boys the mental training is valuable, since they have much of this to learn,

and they will take it more to heart if they learn it through the means of a sport which they enjoy. Personal contact of one contestant with another is feasible here, since the body of a boy can stand the strain better than that of a man, and all the qualities that go to make up manliness, courage, and self-control are brought into play the moment the game begins. This is a much-misunderstood subject, and we are constantly hearing complaints of parents against the roughness of their boys' games. Many of the sports are rough, and more or less serious injuries occasionally result; but while the injuries are to be sincerely deplored, it was long ago demonstrated that the valuable qualities of mind which are what make a man worthy of his Maker can be taught a boy in no other way more effectually than in these games of his youth. They are quite as beneficial to older men, but the man's time can not, as a rule, be given to such matters, and his physique will not bear the strain.

Where there are several members in the contest, ranged in two opposite sides, the presence of two leaders is necessary. Hence the beginnings of organization, of discipline, of command and obedience, and of study in the theory of what is termed "team play," and perhaps, most important of all, of emulation. This kind of training of youth is valuable beyond all estimate. It is proved day by day in the schools and colleges, and no school, however small, should be without its organized athletic association in football, baseball, rowing, tennis, track athletics, lacrosse, cricket, and all the other games which are played to-day. Far from detracting from the boy's studies, all this supplements them, training not only the body to fit the mind for study, but strengthening the qualities of mind which are as important in athletics as they are in mathematics. The only objection to the present athletic systems in certain schools is that but half the scholars receive this athletic training, whereas all should, in one form or another, be admitted to a part of the education it furnishes.

Every boy who can, should take part in some one of the games mentioned in winter and in summer, practising it each day of the week. This makes it quite unnecessary for him to go into any special-development training, unless there is some organic or chronic weakness which a physician thinks that physical exercise of a special nature can rectify. The system should be briefly as follows: Each day at four o'clock, rain or shine, during the entire year, Sundays, of course, excepted, he should dress for the particular sport in season. Then, going out, he should take part in and study this game from one to two hours, depending upon the nature of the game itself. After this the player should return to his home or gymnasium, at once go into a bath—shower, if possible—and bathe first in warm water and then in a cold shower. He should then dress and go to his meal within an hour.

Desultory playing of any game is of no value. The "scrub" game of ball, the sudden sprint race of boys in ordinary costume, the desultory kicking about of a football, are in a measure, distinctly injurious. Nothing of value is learned, time is wasted, and the habit of doing a thing by halves is easily formed in this way. On the other hand, a thoroughly business-like organization, with a commander chosen from among themselves by the boys, involves the beginnings of a systematic and careful study on the part of both captain and men. It means a study of the correct way of doing what is in hand, and consequently the development of all mental qualities worth cultivating. And it means, also, correct physical training and greater pleasure.

Evils of Desultory Sport.

It may not be out of place to add here that military training in schools serves much the same purpose, since it brings into use practically the same matters, physical training occupying, however, a much less important part. It is to be hoped, therefore, that military drill will soon be introduced into the schools of the United States both for the good that it will bring and for the preparation it will afford the Government for an army in time of war.

INDOOR EXERCISES.

Nothing has been hinted at so far except outdoor exercises, and for this reason much that I have said may have seemed incomplete. In a measure this is true; but the method used illustrates one of the most important points in physical training, and one in regard to which many teachers have fallen into an error. It is proper to explain this here.

The highest aim of physical training is health, which can be amplified to include the restoration and the maintenance of health. It is in this sense that the subject is treated here. There is, however, a common error frequently committed by instructors on the subject to the effect that the purpose of physical training is to increase the size of the muscles of the body. While this is in a measure true, its very truth is what causes the error. Exercise does increase the size of muscles during the process of making them healthy and vigorous. The increased size, however, is a secondary result, not by any means the purpose or cause of the training. Large muscles, unusual dimensions of calf, thigh, biceps, chest, etc., are, for many reasons, not to be desired. In the first place, they are often unhealthy. All really healthy men and women have normal-sized muscles; but the converse is not true, for many a man with large muscles has been made unhealthy because of them. Mr. Ferris, the famous Hercules of Boston, and for a long time a gymnasium superintendent there, developed his chest, stomach, and back muscles to such an extent that he took off

all his flesh, which meant the loss of strength, and died suddenly of consumption at less than fifty years of age. There are many such cases, but

FIG. 16.—THE FARNESE HERCULES.

it is enough to say that famous athletes usually die at middle age, and are not healthy human beings. Sandow, wonderful as he is to look upon, is

not to be emulated, for he is not a normal man. Compare the wonderful statue of the Farnese Hercules (Fig. 16) with the Apollo Belvidere (Fig.

FIG. 17.—APOLLO BELVIDERE.

17), or the Hermes of Praxiteles, and you at once see that the two latter represent healthier men.

Aside from the fact that games out of doors in the daylight furnish better air for the lungs and light for the body to work in, aside from the fact that special-development exercises out of doors fill the same conditions, except as concerns mental training, both of these systems can scarcely be used except to maintain health in general. Indoor exercises, on the other hand, with their dumb-bells, their pulley weights, and their other apparatus, have nothing of this training, and in searching for some end to work for in connection with these, the individual discovers that it lies in the endeavour to lift the heaviest load, to pull the body up and down the greatest number of times, to add a half inch to the circumference of the biceps, and so on; all of which might be well enough in itself if it did not tend, when carried too far, to injure the health, and thus defeat the purpose of physical training.

Gymnasium and Home Exercise.

On the other hand, it must not be understood by this that all indoor exercise is injurious. It is not. It is certainly not as helpful as the same amount of exercise out of doors, but in many cases, for special purposes, it is better. Nevertheless, the danger of losing sight of health in the desire for unusual strength is greater when indoor training is taken up than when the question only involves work out of doors.

Indoor exercise can be divided into work in the gymnasium and work at home. The first is for men and women who have some chronic physical weakness which can be best corrected by delicate, precise work under the eye of an instructor, or for men and women who can not find the time or the place in which to take physical exercise out of doors, and who are therefore presented with the alternative of exercising indoors or not at all. In such cases gymnasium work is manifestly the better course. The second course—that is, exercise indoors in your own home —is the last resort, and to be taken in hand when, for any of many reasons, you can neither exercise in any way outdoors nor in a gymnasium. Human nature is naturally unsystematic. The tendency when one is well is to take no exercise. It is hard to make time for a game out of doors, or for an hour in the gymnasium, and hence indoor home exercise includes another class of individuals—a very large one, unfortunately—of men and women who might get any kind of exercise but who do not take the trouble to seek it. They can at least take ten minutes after rising and ten minutes before retiring; and such is the beautiful completeness of our bodies that even this, if carried out regularly, will keep health at hand and ward off disease.

INDOOR GAMES.

With this in view we can turn to indoor exercise, bearing in mind that it is the first downward step from ideal exercise. Naturally, the best form of indoor exercise is to be found in some indoor game, for the reason that a game involves the use of the brain and mind as well as the body. In so far as it does it makes the health-giving quality of

Sparring.

the training greater. Many of the games open to us might be, and indeed are, played out of doors. They are discussed in this connection only as indoor sports, though, of course, where it is possible, they should be carried on out of doors. Sparring, for example, which is one of the finest educators of health, strength, courage and quickness, coolness, decision, accuracy and self-control—all the qualities a mother hopes to see in her son, a wife in her husband, a sister in her brother—is more healthful if carried on out of doors (Fig. 18). As it admits of indoor practice, however, it is generally considered an indoor game. Sparring is often called a brutal sport. This is as much an error as to call football prize-fighting, or gunning murder. Sparring can be and often is brutal, and football, unfortunately, has occasionally been made to look like prize-fighting. Certainly a man may go gunning with murder as his object. But none of these contains the evil in itself unless brought out by the person using it.

FIG. 18.—SPARRING.

In other words, it is what lawyers call the *animus* which makes evil or good out of them, and it would be no more just to stop sparring because Sullivan and Mitchell fought than to stop bird-shooting or deer-stalking because one man shoots another. Sparring brings into play every muscle of the body, and not only educates endurance and strength, but adds quickness and vitality to its other good points, qualities which are so often wanting in indoor exercises. A man or youth can scarcely do better—and from here on the question of outdoor games is not considered—than to spar half an hour a day with either the gymnasium instructor or some friend. But the sparring should be studied, scientific, and thorough—like all other games played for the good there is in it.

Wrestling, in much the same way, is a capital trainer of both mind and body. The teacher is, however, an important factor in wrestling.

Wrestling.

No one should take up the sport without some prior instruction; for it is one of the easiest and simplest ways of straining muscles, nerves, and tendons. In the heat of a contest any wrestler would rather strain a nerve than allow both his shoulders to

go down on the ground together, and for this reason a somewhat long apprenticeship with an instructor is advisable. A man or youth, who is so built that more complex games are impossible, or who can not get more than one other to join him in his athletics, may make up a capital scheme for physical training by alternating with his friend between wrestling and sparring, taking one one day and the other the next. They offset each other admirably. Sparring, while it employs every muscle of the body to a certain extent, makes the upper part of the frame work a little harder than the abdomen and the legs. Wrestling, on the other hand, though general in its muscular development also, uses the legs and abdomen, the side and back muscles more than those about the chest and arms. Both these sports have the great merit of involving no expense.

Rackets, Court Tennis and Lawn Tennis.

Rackets, in a way, is one of the most complete rests and exercises a busy city man can undertake, and while it requires an extremely agile frame, it does not exclude older and stouter men. The quick carroming of the balls, and the general movement required to follow them, is exercise not only for the muscles and the mind, but for the circulation of the blood, which is one of the most important features for men employed in sedentary occupations to bear in mind. Rackets, up to the present, has had the disadvantage of being expensive. It requires an expensive court, and courts are only to be had in clubs. But it is to be hoped that in time racket courts will be put up in many of the Y. M. C. A. gymnasiums that are constantly increasing in the different parts of the world. In good time both this and court tennis promise to become more feasible for the average mortal. There is, however, one thing to be said concerning such games. The racket held in the right hand cultivates the right side at the expense of the left. This should be avoided, not by special-development exercises for the left side, but by playing at least half the time with the left hand. It can be done equally well with a little practice and a little persistence. As this danger is a constant one, however, these games are not as general in their development as sparring and wrestling.

Court tennis and lawn tennis played indoors are both admirable exercises, though court tennis and rackets are probably better than the other. The indoor lawn tennis necessitates a very large room without posts, and this is expensive even for a club to build.

Handball.

Handball has many of the qualities of rackets, and it is much more within the means of the average man. It requires but a small court, and these are now being put up in most Y. M. C. A. gymnasiums. If you can get half an hour six days in the week in a handball court, you will find that your muscles are being very thoroughly and very generally used, and that by the end of two months

you have a most vigorous circulation. Handball, indeed, is becoming a favourite game for young and middle-aged men. Many newspaper men—who work at night, sleep late in the morning, and only have their afternoons to themselves—are apt to play handball in the early afternoons. This "sets them up" for the evening's work at a small expense, and gives them a great deal of pleasant enjoyment. It is as important here as elsewhere to remember that both hands must be used in hitting the ball, or the sides of the body will not be developed equally. If this is strictly adhered to, the shoulders, back, side, waist, and abdominal muscles receive a most thorough shaking up before the half hour is over. The legs come in for their share of the work also; but if more is desired for them, a mile jog around the track of the gymnasium at the end of the handball game will equalize the practice of all the parts of the body. Perhaps, everything considered, there is nothing more feasible for the middle-aged and older man in gymnasium work which furnishes so much normal and healthy exercise for a small outlay.

There has been introduced into America within the last few years a new game that has many of the attributes of both lacrosse and football, so far as that is possible within doors. This is basket ball. For the benefit of those who do not know the game, it may be said that it is played on the gymnasium floor. There are two sides of eleven, or any given number, each. The object is to toss a large leather or rubber ball into a basket about the size of an ordinary peach basket, which hangs from the ceiling fifteen feet above the floor. The game is very exciting and the exercise is general in every way, involving an amount of skill which precludes any idea of inattention on the part of the players. A team of basket-ball players can be easily organized wherever there is a gymnasium, and half an hour of play three times a week, with some other light special exercise, forms a good substitute during the winter months for the more vigorous outdoor games. One of the great advantages of the game is that it can be played by girls. Indeed, it is played at present at such institutions as Smith College. Handball is also within the sphere of women, although it does not seem to have acquired the popularity of basket ball. When played by girls, basket ball should receive its due like other sports, and be an organized contest, the girls practising in regular teams. Girls, however, should not play with boys in this or any other indoor game involving such exercise.

Basket Ball.

These sports are in the main general and equally distributed physical exercise, with the exception of tennis and rackets, which, as has been intimated, are apt to develop the right side at the expense of the left, unless care be taken to avoid it. We now come to two representative games that have not the merit of general development.

Fencing.

Fencing has hardly an equal among physical exercises in the development of grace, agility, and quickness (Fig. 19). It requires more *finesse*, more delicate skill than almost any other sport, and as such it is a beneficial exercise. It, however, develops only the right side unless the fencer can play the rapier with either the right or the left hand; but this is so unusual that it is practically impossible. Any one undertaking fencing must for this reason finish off his hour of exercise with some special movements to bring the left arm and shoulder up to the standard of its mate. If this is thoroughly done, there is no danger of unequal development. Bearing this in mind, girls and young women may secure grace and health by fencing a short time each day—fifteen minutes to half an hour, with fifteen minutes added for special work on the left arm. So far as women's fencing is concerned, it should be confined to the rapier; but men may take up any of the other forms, such as the fencing of the German duellist, sabre exercise, or any of the other sword sports. The rapier is, however, the best physical exercise of all in its general as well as its special results.

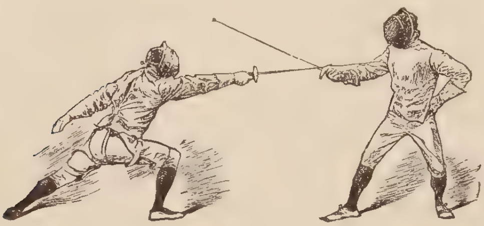


Fig. 19.—Fencing.

Single Sticks.

The other of these two one-sided sports is single-stick play, which can, though with difficulty, be practised with the left hand. It bears a close resemblance to fencing so far as the general exercise it furnishes goes, but fencing requires more skill (Fig. 20).

These last, though they exercise the muscles of the legs, do not give them as great or as universal development as they do the upper part of the body, and to counteract this the boy or young man may to advantage add other forms of exercise which can still be said legitimately to belong to games. These are such sports as high jumping, high kicking, and tumbling, all bringing into good play the lower muscles of the body, and yet retaining the idea of defeat and victory. None of the latter, however, are sufficient in themselves, and no one searching for some single

Fig. 20.—Single sticks.

sport which he may go into for the general maintenance of a healthy body should rely on these alone. If, however—and this may be said of most Americans—the upper body is more fully developed than the muscles of the legs, it may be well to adopt the plan of trying at high jumping certain times during the week after the general-development game has been given its required time for the day. This is true also of such games as bowling, which do not go far to keep up physical culture, and at best act only as a stimulus to the circulation.

Badminton and Battledore and Shuttlecock.

Indoor games are naturally limited almost entirely to the gymnasium, since it is there alone that the necessary apparatus and room are to be found for carrying out the details of the different sports. The house and home are not without athletic games, however. One would scarcely believe how much physical exercise there is in such a game as badminton or battledore and shuttlecock until one has played either steadily for half an hour. The difficulty with such sports always lies in the fact that the players do not look upon them as anything more than pleasant amusements; and whereas a man or woman would never think of going to a gymnasium to exercise unless dressed in athletic costume, both will play badminton in evening dress. The result is hard exercise in cramped clothing, natural perspiration without being followed by a bath and a change of clothing, and finally a cold which will more than take away the good effects of the exercise. As they are generally played, therefore, these two games are not as beneficial as some of the special exercises which can be taken up at home as well as in the gymnasium. And this brings us to the much-vexed question of special-development exercises themselves, and to the great field of usefulness which the gymnasium fills.

SPECIAL INDOOR EXERCISES.

Indoor special exercises, as has several times been intimated, are makeshifts for want of something better. They are at the same time the poorest form of general physical training, the best method for bringing up an organic or chronic weakness of particular parts of the body, and the most common method of systematic exercise among men, women, and children for the reason that all classes find themselves more apt to keep regularly at work in this way under the eye of an instructor than when left to themselves. Gymnasiums, therefore, are filling a most valuable place in the community, and as cities grow in size and it becomes impossible for human beings to get into the open air for systematic exercise, gymnasiums are sure to become important means for maintaining the health of the community. Having looked at the question from one

side and urged that the individual should play games out of doors in the sunshine, we may also, without contradiction, say that special detail exercises indoors and at night are far better than no exercise at all.

Punching Bag.

One of the best gymnasium trainers is the punching bag. It consists of a superstructure similar to a circular sounding board, still seen occasionally over the pulpit in a church. From the centre of this hangs a leather bag about the size of a football, filled with air, so that it swings from its rope at about the height of a man's head above the floor (Fig. 21). By giving it a quick blow it swings out and upward until it hits the sounding board, when it rebounds again with added velocity. The person practising with it must then give it a

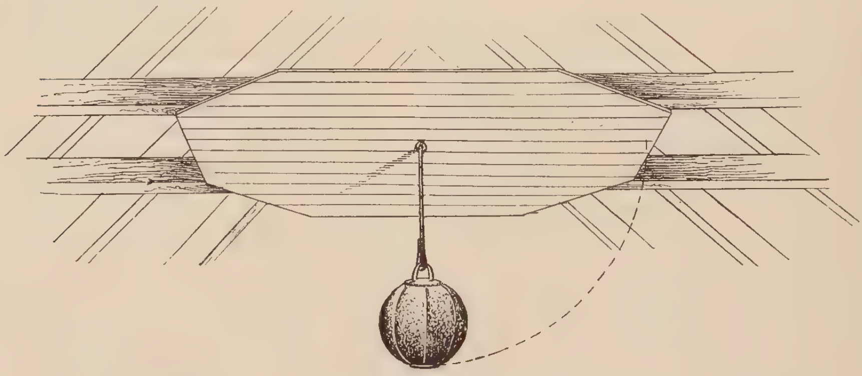


FIG. 21.—PUNCHING BAG.

second blow before it swings beyond the centre of its arc. Otherwise it will itself give him a severe blow. In a moment the bag is swinging hither and thither, and the puncher must be indeed quick and active to catch it squarely each time it approaches. This bag exercises the muscles of the arm especially, but in reality the chest and back muscles are getting severe work, and those of the leg and waist are coming in for a reasonably good share of the exercise. In the meantime the mind has been employed to the exclusion of all else for the time being, which is most uncommon in exercises not involving a game. Half an hour a day at this lively bag is a wonderful chest "opener." In striking, the blows should be of all kinds—direct from the shoulder, round arm, upper cuts, and all the varieties known in boxing. In fact, it is a species of solitaire boxing, and comes as near reaching the real thing in its good points as any imitation can.

Indian Clubs.

Another capital chest and arm developer is Indian-club swinging, which is familiar to every one. The position should be a rigidly upright one, heels and knees together, chest out, shoulders back, and head up. In all the evolutions of the clubs the

whole body except the arms should be as nearly rigid as possible. These exercises are especially beneficial to the hand, forearm, biceps, triceps, and pectoral muscles, and so far as they go they are admirable. The great advantage of Indian clubs is that one may keep them at home and swing them night and morning. The exercise is general so far as the upper part of the body is concerned, and it admits women among its devotees. The clubs themselves should not weigh over two pounds apiece, and one and a half is far better.

Rowing Machine.

The rowing machine, which is simply a mechanical imitation of an oar, gives the body the same exercise that rowing does. It develops the arms and the chest and back, besides incidentally using the leg muscles to a limited extent. The swaying motion also exercises the abdominal and side muscles, but, as in rowing itself, the machine is too precise to allow one to use it extensively without poor results. No exercise that has for its object the absolute repetition of the same movement an indefinite number of times can be as valuable as something involving variety of movement. A short practice each day on a rowing machine, with some other irregular developer, such as jogging around the track, or jumping or wrestling, may, on the other hand, produce good results. The objects to be sought when using this machine are to assume and preserve the correct rowing position, to then go through the movements of a stroke, bending the knees, moving the sliding seat forward, letting the body sink between the knees, and then "catching" the oars in the (supposed) water and pulling the stroke through by straightening the back, thrusting the knees down, and pulling the oar in to the body. To use a rowing machine properly it is necessary to learn the stroke first from some competent person.

Running in the Gymnasium, and Tumbling.

To offset these special developers of the upper part of the body there is jogging around the gymnasium track. Here, again, the person adopting this particular exercise must learn the one right way of carrying it out. Running in the gymnasium is only different from running outdoors in that one must go much slower on account of the frequent turnings. Otherwise the position of the chest, head, and arms is the same, and the runner must here, as well as outdoors, run entirely on the ball of his foot. It is always a good plan to close the day's exercise in the gymnasium with a mile or more on the track, done at this slow, swinging jog. The action fills the lungs, starts profuse perspiration, and prepares the individual for his bath, which should follow very soon after the run is over. Tumbling is another good leg exercise to counteract the punching bag, Indian clubs, and rowing machine. But tumbling is a science in itself, which must necessarily be practised under the eye of a teacher for some time before it becomes an exercise to be indulged in to any great extent.

Parallel bars, the vaulting and horizontal bars, the flying rings, and the other general arm and chest developers are familiar to any one who has been inside a gymnasium, and they do not need discussion here. They are all special in their nature, as are the different apparatus known generally as pulley weights. The larger and more complete gymnasiums become, the more extensive are these different special apparatus.*

Parallel Bars, etc.

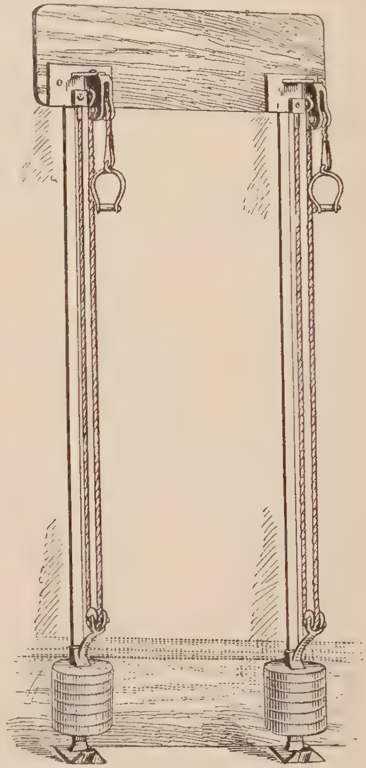


Fig. 22.—Ordinary pulley weights for home or gymnasium use.

All of these have their value in aiding individuals to bring up to the standard different muscles of their bodies at present below the average. For the reader of this article it is enough to say that if he is merely seeking general exercise in this way the proper course is to learn the object of each apparatus and use it a short time every day as a part of the development course he has prescribed for himself. See that all the muscles have some exercise each day, whether all the apparatus are used in so doing or not. If, on the other hand, any particular part of the body is under developed, if the shoulders are "round" or the right side higher than the left, or any other defect is visible, one should go to the gymnasium instructor or use Dr. Sargent's charts and add this special exercise to the general work of each day.

* Dr. Dudley A. Sargent, the director of the Hemenway Gymnasium, Cambridge, Mass., has invented a large number of these pulley weights, each intended to exercise special muscles, and he furnishes descriptions of them to any one. Indeed, many of these have been adopted already in other gymnasiums to great advantage. In his carefully arranged anthropometric charts, Dr. Sargent shows graphically what after years of research are found to be the normal measurements for a boy, a girl, a young, middle-aged, or old man or woman; and the man of thirty, for example, can procure the particular chart that shows the normal measurements of a man of that age and compare it with his own muscular measurement. Then in one of Dr. Sargent's books he will find careful descriptions of the different gymnasium apparatus, and can proceed to exercise with those which are intended to develop the muscles he finds in his case below the average.

THE HOME GYMNASIUM.

But none of these apparatus are to be found at home, and many persons can not, or think they can not, afford a gymnasium membership, or the time required for the exercise there. It is thus that the question of home development asserts itself, where, without apparatus, the individual wishes to keep his healthy physical condition. If you have a garret you can fit it up as a little gymnasium without much expense. A pair of pulley weights (Fig. 22) can be purchased, or a rowing machine, or dumb-bells. Or, if there is no garret, the door of the closet in your room may be turned into a small gymnasium itself by having nailed at either side of the frame on the inside of the door about three inches below the top a piece of wood an inch thick by several inches square, having on its upper side a socket or groove. In these two grooves rest a stout round bar perhaps an inch and a half or two inches in diameter, cut to a length which permits it to fit between the two sides of the door frame and rest on the grooves (Fig. 23). Here is a horizontal bar which you may grasp, and by which you can pull yourself up to the chin as many times as possible. Another pair of these grooves, or supports, may be nailed in a similar manner three feet above the floor, and if the bar be transferred to these it offers an opportunity for a limited practice of horizontal-bar work.

Home Horizontal Bar.

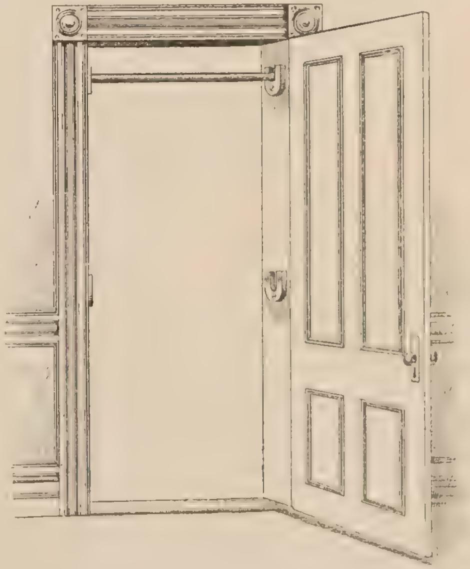


Fig. 23.—The home gymnasium: horizontal bar.

At another small expenditure a capital parallel-bar effect can be produced. Have the carpenter make a small apparatus similar to what painters attach to the windows of a house (but in the reverse position) to hold up the plank on which they stand while painting the outside of a house. It consists of two horizontal poles, two inches in diameter and about three feet long, running out of the window on the sill, and being clamped outside under the sill each by a piece of iron. Six inches from the ends (which extend into your

Home Parallel Bars.

bedroom) braces run to the floor, where it meets the wash board, and at this lower end the two braces are joined by a stout piece of plank (Fig. 24). This apparatus can be taken out and in without any inconvenience, and, as it necessitates keeping the window open while it is in place, you are sure to exercise in fresh air, which is one of the necessaries of the home gymnasium. In fact, all such exercise taken in a room should begin with the opening of all the windows. Mr. Blakie * suggests simpler but not quite so suitable parallel bars. He has two short two-inch-diameter poles, not more than six inches in length, each fastened to the inside of the door frame about three feet from the floor, by which you can push yourself up and down by grasping the ends of the short poles. Dr. Sargent has also invented several apparatus for use in the house, which can be prepared at small expense if the room admits of it, all of which are admirable.

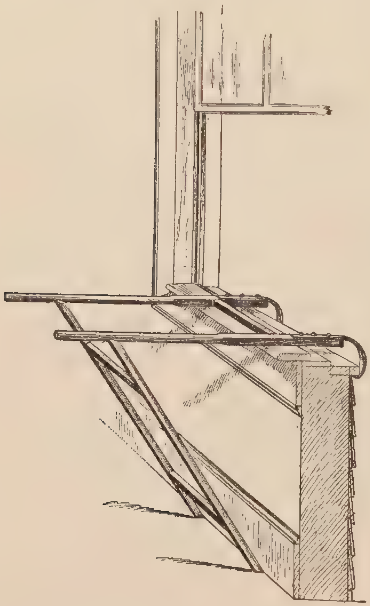


Fig. 24.—The home gymnasium: parallel bars in the window.

It is not necessary, however, to have these if a man wants to go into training to that extent, since he can become a member of some Y. M. C. A. gymnasium or athletic club, paying less in fees than he would in having the apparatus constructed. If you have these apparatus you can do somewhat more thorough work, but if not, there is still enough left to make half an hour a day of most beneficial exercise, and it is this which must interest us most now. First comes the development of the arm.

THE ARM.

The muscles in the arm are, from the point of view of training, four: The biceps in front of the upper arm, the triceps behind the biceps, the forearm between wrist and elbow, and the wrist and hand muscles. In developing the arm one should carry in each hand a dumb-bell which should not weigh under any circumstances over a pound and a half to two pounds—that is, at most these two dumb-bells should not together weigh over four pounds. There is never a greater mistake made than

* In his *How to get Strong and stay so*, an admirable book, but too much devoted to muscular development alone.

the use of eight- or ten-pound iron dumb-bells, or even five-pound ones. They do not add to the stimulus given to circulation by the different movements, and they strain the muscles unless one happens to be an old and experienced dumb-bell user in good condition. Even then they do not add to the healthfulness of the exercise, the sum total of the good in them being simply that they increase the size of already big muscles, for only large muscles should use them. And to gather a big set of muscles on the chest or about the bones is, as I have said, rather a low ideal for ambition to look up or down to. *So far as health is concerned, two pounds apiece is the outside weight of dumb-bells, and they should be of wood.*

The Biceps.

To exercise the biceps, grasp these dumb-bells one in each hand. Put all the muscles of the arms at tension—that is, strain them to harden all the muscles in them as much as possible. To begin with, the arms are hanging straight down at the side, the fingers pointing to the rear. Now gradually and very slowly raise the dumb-bells by bending the elbows, keeping up the tension all the while, and gradually turning the wrist so that when the dumb-bells are close up with the shoulders the fingers are still pointing to the rear. Then, without stopping, without a jerk of any kind, when the upward movement is finished, lower the hands again, turning the wrist until the arms are once more at the side, fingers pointing to the rear. Begin the same movement again without relaxing the muscles. This should not be repeated over twenty-five times at first, and in any case it should be constantly borne in mind that the moment a feeling of weariness appears that particular movement which is causing it should be stopped for the time being. This is the best movement to begin on, though anything which brings the hands in toward the shoulders by bending the elbows is good for the biceps.

If pulley weights are in the house, use them in the general motion of rowing, or as described above. Or, if you have a rowing machine, that will give the biceps along with other muscles much the same exercise. After practising at this some days, until the lameness has gone out of the biceps, it is well to put the horizontal bar in the lower of its two positions, and then, sitting on the doorsill, to pull yourself just clear of the floor with your arms. The whole movement should not be more than three inches upward. Later still the practice of "chinning the bar" can be tried.

The Triceps.

The triceps are the muscles behind the biceps at the back of the upper arm, and they do the pushing for the arms. Every time one pushes against anything by straightening the arms out this muscle is brought into play. To exercise it, begin by thrusting the two-pound dumb-bells straight up over the head with the same slow, regular movement as already described, keeping the muscles

tense all the time by gripping the bells hard. This alone will strengthen and keep strong the triceps, but in time more vigorous pushing movements can be taken up; for example, lean against a wall and push your body back and forth on the toes as a pivot. Several weeks later, when the triceps are in better training, lie flat on the chest, and, touching only the toes and the palms of the hands to the floor (Fig. 25), slowly push the rigid body upward until the arms are straight. This is a

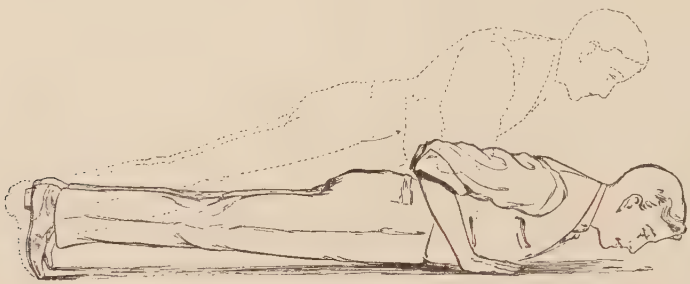


FIG. 25.—DEVELOPING THE TRICEPS AND SHOULDER MUSCLES.

severe test, and should only be done two or three times at the start. Finally, grasp the ends of the parallel bars set into the window as described, and lower yourself between them, then slowly push the body up till your arms are again straight. This is the most severe exercise of all for the triceps, and is only to be practised after long training. If taken up earlier, there is great danger of rupturing a tendon or injuring the muscle in some other way.

The Forearm.

The forearm was somewhat exercised when the dumb-bells were being raised to the shoulders by the turn given the hand. And in fact it is difficult to develop the biceps and triceps without also developing the forearm. Another plan is to hold the arm straight down at the side a little away from the body, and to then "twirl" the bells—that is, twist the hand to the right as far as it will go without bending the arm, and then reverse the movement as far to the left as possible, all the time grasping the bells firmly. Still, again, grasp the bells vigorously, palms up and arms out in front horizontally a little bent at the elbow. Then turn the hand at the wrist up and toward the face as far as it will go without moving any other portion of the arm. Repeat this, and in a moment you will feel the forearm muscles. As a matter of fact, however, the forearm is always exercised with the biceps and triceps.

The Hand.

The hand can be exercised by continually opening and shutting it firmly, and by alternately grasping and letting go of anything.

It should be remembered, in connection with the arm exercises, that

weights are neither proper nor necessary. As has been said, after a long practise of a year or more, if weights are used they will increase the size of the muscles, but they never add one iota to the health or symmetry of them, and there is the constant danger of rupture. Indeed, the idea of weights of more than two pounds should be given up in connection with this home gymnasium.

THE LEG.

The leg is divided, so far as exercise is concerned, into the muscles of the calf and the front and back thigh, those of the foot being exercised at the same time with the calf. One of the best ways to bring the calf up to the normal standard is to stand upright, knees together, and to then rise slowly on the toes as far as possible, the muscles of the legs being at tension, as already described in the arm. This movement also should be slow and steady, and care should be taken not to rest the body on the heels when you come back to your original position. In order to avoid losing the balance, stand near a wall and steady yourself by touching it with one hand. Once you have become accustomed to doing this fifty times without stopping—and it will be some time before this will be the case—try the same movement first on one foot alone and then on the other. Naturally, any general leg exercise brings in the calves as well as the thighs; but for indoor, at-home development this one movement is quite sufficient, with perhaps the added action of hopping lightly on one foot up and down without touching the heels at all.

The Calf.

The muscles of the thigh are twofold—front and back. The front muscles are best exercised by standing erect, holding two-pound dumb-bells in either hand at the sides, and then bending the knees and lowering the body until the bells touch the ground. The return to the upright position will tax these muscles hardily at first. This movement should be done carefully, otherwise the muscles will stiffen and be lame for days. But in time the same motion can be gone through on one leg alone. It is also a homely but a capital exercise to go up and down (backward) a flight of stairs for six or eight times at the start, and more later, always slowly, in order that each leg may have as complete a movement as possible. No one can imagine what an extraordinary exercise this is till he tries it, moving on the toes entirely and giving the leg muscles all the exercise possible in the process instead of trying to save them.

The Thigh.

The back thigh muscles have some little exercise in all this, but it is well to invent some special work for them. One of the best movements for this purpose is high kicking. Hang a tamboureen or anything of the

sort from a chandelier at about the height of the shoulder; then, standing on the left foot, swing the right leg quickly up and hit the tamboureen. Without allowing the right foot to touch the ground, repeat the kick, and continue for ten or fifteen times. Then do the same with the left leg. The same result is obtained by trying to touch the hands to the ground without bending the knees.

SHOULDERS, BACK, AND CHEST.

The muscles about the shoulders, back, and chest are so closely connected that almost any general exercise suggested here for any one of them will necessarily give practice to the other two.

The Shoulders.

Some are naturally better for one than the other, and hence, for the shoulders, grasp the dumb-bells firmly, the hands and arms hanging naturally at the sides. Raise both arms straight and stiff out from the body until they have gone above the horizontal line as far as they will go without bending the elbow. Then lower slowly and with the muscles always at tension. In other words, go through the motion of flapping wings; but of course this should be done slowly. You will soon notice that the muscles over the top of the shoulders are growing tired. Again, with the arms hanging as before, raise them slowly (parallel to each other) out behind the body as high as possible. This brings in the muscles just above the shoulder blades, as well as those below and under the shoulders. Then, if you have a rowing machine, use it temperately. If not, sit on the floor as if on a rowing machine and go through the movements, holding the dumb-bells in the hands. In doing either of these movements, remember that line in the old English boating song, and "keep your body between your knees"; that is, as you come forward open the knees and force both the chest and abdomen far forward, bending the back concavely and holding the shoulders as far back as possible. Another general exercise for the shoulders may be described in the following way: Suppose two wheels with a radius the length of your arm were set upon a short axle, the axle lying across the shoulders behind the neck. On either side of you there would then be a large wheel. Grasp with each hand the tire of one of these imaginary wheels, and, moving from front upward over the head and back, turn the wheels around very slowly. This makes a rotary motion with both arms holding the dumb-bells and only bending the elbow a little at the point where it is necessary to do so to complete the curve downward behind you. It is an extraordinary shoulder and chest developer, and should be executed very slowly, with the muscles at tension and the chest inflated. Try it three or four times, and the shoulders will fairly ache.

It should be remembered in all these shoulder movements that the slightest feeling of weariness is a sign that it is time to stop.

The Back.

The back, during these last exercises, has been receiving some development, especially during the rowing movement. Any stooping motion is a good back developer also. But one should never try weight-lifting for this purpose, since, while it does exercise the back muscles, it tends to pull them out of shape, deadens them, and in time makes a man muscle-bound and round-shouldered. As a rule, the average man needs back-muscle less than chest-muscle training, since most manual occupations involve work for the back. On the other hand, not only are the chest muscles not so much used, but they need to be more fully developed than the back, because during the process of exercising them the individual is "opening" his lungs, and the lungs are the organs of the body that need the most gentle care, for they do the body an inestimable service every instant during life, whether their possessor be sleeping or waking.

The Chest.

For the chest muscles themselves, one of the best, perhaps the best, exercise is to have two poles set up in the room in some such manner as the two poles in an ordinary cow's stall, between which the unfortunate animal is obliged to keep her head. Placing these poles far enough apart to allow the shoulders to pass between—say twenty-four to thirty inches—the exercise consists in grasping each pole with a hand at about the height of the shoulder and then allowing the chest, head, and shoulders (with the head as far back as possible) to swing between the bars. Then force the body back again on the toes as a pivot, and continue for perhaps twenty times at first. The chest muscles soon begin to show they are being used. I remember a man who developed these muscles at his home where he had no poles—not even a cow's stall—by simply opening the door of his room about two feet and placing one hand on the end of the door and the other on the door frame. This exercise also develops the back between the shoulder blades.

If the person who is going through all these exercises in his room invariably keeps his head thrown back and his chest well out, while keeping his lungs full of air—if he does all this, he sufficiently exercises the lungs themselves, and need think of no special work for them. One of the most convenient as well as the most thorough exercises for chest, shoulders, upper back, biceps, and triceps was told me once by Dr. W. S. Williams, of New York, who has made physical exercise a careful study for years. The great merit of it is that it can be practised anywhere—at the office without rising from the desk, in the cars on the way home, at the theatre, even in church, if necessary. It consists in grasping the back of the left hand with the right hand. This brings the two hands against

the chest bone. They should not touch the body, however, but be held about two inches from it. The elbows should be held a little lower than the hands and not quite so close to the body. In other words, the line from elbow to elbow along the forearms and across the hands should not be straight, but should form a large obtuse angle with the hands for a vertex. In this position stand upright or sit upright, chest out and head thrown back, and pull as if trying to separate the hands. Pull steadily for about two seconds. Then reverse the tension and push as hard and steadily, without changing the position in any way, for another two seconds. Repeat this twenty-five times, and do it so hard that the muscles quiver and the teeth "grit." Whenever the back, arms, or chest ache from leaning over a desk, at any time of the day or night, this simple but extraordinary exercise, if tried for five minutes, will give one a complete rest, will fill the lungs, and compensate the muscles for a long period of unnatural position.

THE ABDOMINAL AND SIDE MUSCLES.

We have now to say a word as to the muscles of the abdomen and side. The abdominal muscles are most thoroughly exercised by the person lying flat on his back, clinching his feet under the side board of the bed, and raising the upper part of his body slowly and steadily to a sitting posture (Fig. 26). Then, without

The Abdomen.

FIG. 26.—EXERCISING THE ABDOMINAL AND FRONT THIGH MUSCLES.

making a stop or jerk at the top, the body should be lowered again to a horizontal position. During this movement the hands and arms may be

either held at the side, folded across the chest, or locked behind the head. Continuing this without letting the shoulders touch the floor at all, it will soon be found that the muscles across the stomach are having their share

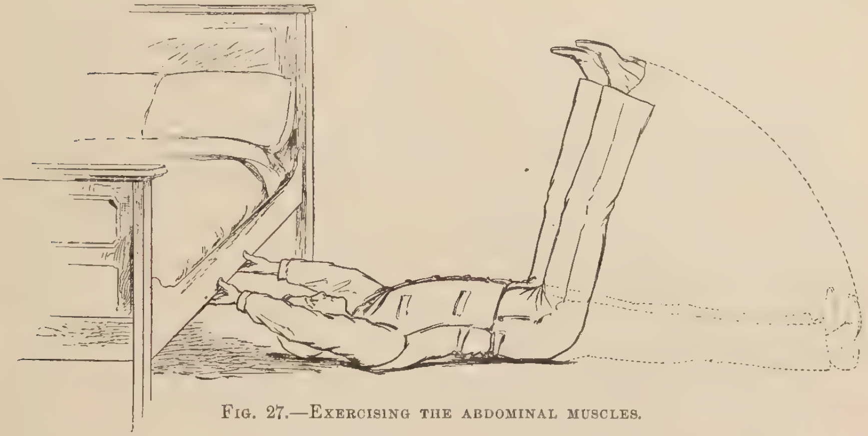


Fig. 27.—Exercising the abdominal muscles.

of work. A good variety on this movement is to raise the legs without bending, except at the waist, and keeping the upper part of the body on the floor by placing the arms, extended over the head, under the side board of the bed (Fig. 27).

The Side Muscles.

For the side muscles I have never seen a better exercise than to swing both hands together, grasping the two-pound dumb-bells, from the left side up over the head and down as far as possible on the right side, the swaying movement itself beginning from the waist, so that the body swings on the waist as a pivot. If the knees are bent, or if the upper part of the body is permitted to lean forward, the proper effect on the side muscles is defeated.

This slight suggestion as to what can be done at home for the muscles of the body without apparatus is necessarily incomplete. Indeed, it is only intended to be suggestive. There are many books which give accurate and explicit directions for such exercises, and the individual himself can invent hundreds of different movements by simply going through an exercise and with one hand feeling the muscle he wishes to develop. Those exercises that cause this muscle to harden are, of course, the ones he is seeking. But slight as this discussion must necessarily be, it can not be dropped until something has been said as to the particular exercises that are suitable for people of different sexes and different ages.

In the first place, as to the time when the home exercise should be taken. It is difficult and practically impossible for the great body of working people to find time during the day for stopping work, changing the clothes, and taking a systematic half hour for development exercises. The

men of the family are at their offices all day. The women are full of the labours connected with the house. The boys are taking their exercises out of doors when not in school, and the girls are either at school or attending to their share of the housekeeping. There are but two times in the day when exercises of this sort can be taken, and these are immediately after rising in the morning and immediately before retiring at night. And, as it happens, these two short periods of the day are the best that could be chosen for the particular kinds of exercise to be undertaken. Immediately after rising in the morning one has had a long rest, the muscles are set and numb, as witness the universal desire to stretch the moment one wakes. Furthermore, one does not have to undress to prepare for the exercise. In like manner, just before retiring one is also ready, so far as costume goes, and if all the muscles are given a healthful stretching, the circulation is stimulated in a way to give it a clear passage for the work it must do, while its possessor sleeps, in building up tissues worn out during the day. For the man or woman who can take no other exercise, these two quarters of an hour are the time in which they must save themselves from sickness.

The Time for Special Exercises.

SPECIAL INDOOR EXERCISES FOR MEN.

The average person to whom we may consider this section as addressed would be a man at work either in a city or town, or near one or the other. This might extend on the one side to the farmer and the miner, and on the other to the bank clerk and merchant. In all cases the order of the trainer would be to exercise out of doors—at some game, if possible. For the moment, however, we are only considering indoor exercise. Under the circumstances, therefore, the next order would be to play a game in a gymnasium; and if that were impossible, to exercise in a gymnasium; and if the gymnasium were not at hand, to carry on the home exercise.

For the city man who is at or beyond middle age, and who is almost certain to be at his desk all day, the day's exercise should be as follows: (1) Rise at 7.30; (2) strip entirely; (3) take two two-pound wooden dumb-bells and (4) stand erect (in all these exercises keep the lungs full of air, and have the head and chest out); (5) rise on the toes fifty times (but only execute these movements as long as you are not wearied; in two weeks you will be able to do fifty without feeling a strain on the muscles—begin with ten or fifteen); (6) then bend the knees, let the body fall and rise again, first ten or fifteen times and finally fifty; (7) kick a tamboureen with each foot twenty times, at first only five times; (8) sway the dumb-bells, arms extended, in an arc from

In Middle Age.

left to right, and reverse over the head twenty-five times, beginning with five times; (9) lying on the back, feet under the bed, rise to a sitting posture ten times, at first only two or three times; (10) reverse the movement and raise the feet the same number of times; (11) "curl" dumb-bells thirty times, beginning with ten at first; (12) thrust dumb-bells straight up over the head the same number of times; (13) stretch them out behind as high as possible, the arms being parallel, the same number of times; (14) raise them from the vertical position at the side, till the arms form a horizontal line, the same number of times; (15) swing the rotary motion from the front up over the head backward, both arms going together, the same number of times.

It should be noticed that any man from middle age up can do all these exercises easily except, perhaps, those intended to develop the abdominal muscles; but in a short time these will become as easy as the others. Furthermore, there is no expense required except for the purchase of dumb-bells. Even this small expenditure was saved by a friend of mine, who took a pair of his heavy shoes, weighing together four pounds, and used them in place of dumb-bells.

Suitable Apparatus for Home Exercise.

If expense is not too important an item, two or three apparatus will add to the interest of this work as well as to the benefit to be obtained from it. For example, there is nothing better for home exercise than a punching bag. If you have a garret or store room with timbers instead of plastering for the ceiling, have part of this ceiling boarded over to look like the sounding board of a pulpit and the rest of the punching-bag apparatus made as already described. Or a rowing machine may be purchased, and a set of pulley weights, Indian clubs, and any of the other common apparatus that the individual's pocketbook will permit him to purchase.

For Young Men.

For a man under thirty the exercise can naturally be a little more severe. He should in a short time take one foot off the ground and go through the exercises on the other alone. These exercises include those given above under Nos. 5, 6, and 7, the latter involving a leap, and these being accomplished on one foot, the same should be repeated with the other. Then exercises 9 and 10 should be doubled, and the movement (already described) of lying flat on the stomach and, with only palms and toes touching the floor, pushing the body up till both arms are straight, can be included. Also, men under thirty ought to run a little each day, or at least several days of the week. This can be done in light clothing in back streets after dark, if not in the daytime; and Indian clubs are quite sufficient to take the place of the dumb-bell exercises. Indeed, only the merest suggestion can be given here, and what novel-writers call "the intelligent reader" must use his intelligence and invent various systems for himself, only bearing in mind

that any exercise which strains or wearies is perhaps not bad, but at any rate unnecessary, and in the absence of some experienced person had better be omitted.

Five-minute Exercises.

During the day five-minute exercises can often be taken, wherever you may be, in some such form as described above for the shoulders, chest, and arms. All these exercises should be begun very easily, and should never be over fifteen to twenty minutes, the reader bearing in mind that it is the regularity and not the extent or long continuance at any one time that brings the result we are all striving after—health.

SPECIAL INDOOR EXERCISES FOR WOMEN.

In the case of women there is a great deal more to be said than can be said here. The principle is, however, that women must employ moderate exercises, and must stop the moment weariness comes on, even in the slightest degree. The calf, thigh, abdominal, and chest-muscle exercises must be carried out to a less extent than suggested above until at least several months have passed. A woman, however, like a man, should rise at a certain hour each day and go through her development exercises at once, following these with a bath. All violent movements should be avoided. For this reason such exercises as those numbered 7, 9, and 10 should be avoided until part of the year has gone by and the frame is well seasoned for such things. But, on the other hand, movements tending to open the chest, such as that involving the use of the two upright poles, already suggested, are capital for women. To give a scheme for a woman from twenty years of age upward, the following might be suggested: (1) Rise on the toes; (2) bend the knees and lower the body; (3) with the knees stiff, bend forward and touch the floor with the fingers or palms, if possible—each of these fifteen times for the first month; then gradually increase till each can be done fifty times without the least weariness: (4) execute the swaying movement with one- or two-pound dumb-bells, making the arc over the head as described; (5) thrust the dumb-bells straight over the head, (6) out behind and upward, (7) out at the sides and upward, forming a cross with the body; (8) "curl" dumb-bells. Above all, swing Indian clubs weighing not over a pound and a half apiece. It is easy to purchase some pamphlet describing the simple movements; and they develop the shoulders, chest, and upper back in a way that not only adds to a woman's beauty, but, what is far more important, to her health and breathing powers, for it may not be generally known that not one woman in a hundred knows how to breathe. It should also be borne in mind that no woman exercises because she wishes

to be muscular, for a muscular woman should confine herself to a circus. Hence exercise that involves graceful movements is better than detailed development exercise. Indian-club swinging, fencing, and that latest fad of the day—which is fortunately a capital fad when carried on in private—skirt dancing, are better than dumb-bells or pulley-weight work.

Whatever the exercises are, they should be repeated on retiring at night, followed by a dry rub with a towel all over the body.

Swedish System.

Only a word can be said here as to the Swedish system of exercise. Any one who desires to study it practically can easily purchase books and pamphlets giving clear and practical instructions regarding the system. It is sufficient to say here that the Swedish-movement or calisthenic system is in direct contrast to all games and similar exercises such as we have mentioned. In games it is impossible to estimate, as I have already said, the exact amount of physical exercise any particular muscle has received. The exercise is generally healthful in the main, though perhaps containing some possible injury. The Swedish system, on the other hand, is in a measure an exact science. That is, the teacher can tell precisely how much physical exercise each and every muscle of his scholar's body is at any time receiving. The Swedish system, therefore, is a physical exercise adapted to therapeutic or curing purposes, while games and sports in general are for those who are already healthy, as the word goes, and who merely need exercise to keep them well.

If an arm broken by some accident is finally healed, but remains weak from lack of use, certain movements taken from the Swedish system will in a short time bring it up to the same standard as the other arm, and so on. Whereas no game would be suitable for this purpose. The Swedish system and *massage* treatment are therefore well adapted to cures. The former, in calisthenic form, is used in schools to some extent, but the extent is pitiable when one realizes how many scholars are not given any thorough systematic exercise. The system itself, in brief, involves, first, five *positions:* Standing, sitting, kneeling, lying, and suspending. Then, secondly, from these positions the inventor of the system—a Swede named Ling—evolved what he called *derivative positions*, which include a large number of varied positions. After the derivative positions come *movements*, which include all the motions the body is capable of, whether carried out by the person taking the exercise or by another person, while he sits, stands, lies, hangs, or kneels, and allows his body to remain impassive.

The study of these positions and movements is so complex that a chapter would be required to suggest satisfactorily their practical value to the reader. It must be sufficient to repeat that in the event of some serious trouble with particular parts or muscles or nerves of the body, which

renders it impossible for the person to take general exercise, these muscles or nerves may be strengthened and brought up to standard by the adoption of the Swedish system.

The Delsarte system is practically little more than a branch of the Swedish system, though its theorists would deny this. It is the æsthetic side of physical exercise, and consists of the use of physical exercise to produce grace, charm of figure, and to give the most graphic physical demonstration of the different emotions.

Delsarte System.

SPECIAL INDOOR EXERCISES FOR BOYS.

Boys, on the other hand, do not need these fifteen-minute exercises at morning and night. They are out of doors taking natural exercise constantly, more than either men or women, and for them pulley weights and dumb-bells are a dangerous thing. Every healthy, normal boy is constantly getting a great deal of the best help from old Mother Nature. She is building him up in her own way, and he only needs to keep up quick, vigorous movement of one kind or another. He need not fear jumping, running, and all the other rapid sports in moderation, and, as boyhood is short and we all lose it too soon, we should bespeak for him games in the open air under the sky. Nevertheless, these games should be regularly undertaken. The boy must rise at the same hour each day and retire at the same hour. He must take his cool bath and his hard rub immediately after rising, and the exercise that he has should be taken at the same relative hour each day. Habit is the greatest as well as the worst thing in human nature. Form good habits for the boy's body, and his body will do anything he asks of it in reason. That is a difficult thing, however. No boy naturally wants to be regular, and it is a hard struggle for him to form these habits. Once acquired, however, they are as hard to break as bad habits, and the end is proved to be worth the struggle. If detail exercises are, for one reason or another, advisable in individual cases, there is nothing better than the army and navy "setting-up" exercises, which are as follows:

ARMY SETTING-UP EXERCISES.

First Exercise.

1. *Arm*, 2. EXERCISE, 3. HEAD, 4. UP, 5. DOWN, 6. RAISE.

At the command *exercise*, raise the arms laterally until horizontal, palms upward. HEAD: Raise the arms in a circular direction over the head, tips of fingers touching top of cap over the forehead, backs of fingers in contact their full length, thumbs pointing to the rear, elbows pressed back. UP: Extend the arms upward their full length, palms touching. DOWN: Force them obliquely

back, and gradually let them fall by the sides. RAISE: Raise the arms laterally as prescribed for the second command. Continue by repeating *head, up, down, raise.*

Second Exercise.

1. *Arm*, 2. EXERCISE, 3. FRONT, 4. REAR.

At the command *exercise*, raise the arms laterally, as in First Exercise. FRONT: Swing the arms, extended horizontally to the front, palms touching, heels on the ground. REAR: Swing the arms extended well to the rear, inclining them slightly downward, raising the body upon the toes. Continue by repeating, *front, rear*, till the men, if possible, are able to touch the hands behind the back.

Third Exercise.

1. *Arm*, 2. EXERCISE, 3. CIRCLE.

At the command *exercise*, raise the arms laterally, as in the First Exercise. CIRCLE: Slowly describe a small circle, with each arm upward and backward, from front to rear, the arms not passing in front of the line of the breast. Continue by repeating *circle.*

Fourth Exercise.

1. *Arm*, 2. EXERCISE, 3. SHOULDER, 4. FRONT, 5. REAR.

At the command *exercise*, raise the arms laterally, as in First Exercise. SHOULDER: Place the tips of fingers lightly on top of the shoulders, keeping upper arm horizontal. FRONT: Force the elbows to the front. REAR: Force the elbows back as far as possible. Continue by repeating *front, rear.*

Fifth Exercise.

1. *Hand*, 2. EXERCISE, 3. CLOSE, 4. OPEN.

At the command *exercise*, raise the arms laterally, as in First Exercise. CLOSE: Close the hands with force. OPEN: Open the hands quickly, spreading the fingers and thumbs apart as much as possible. Continue by repeating *close, open.*

Sixth Exercise.

1. *Forearms vertical*, 2. RAISE, 3. UP, 4. DOWN.

At the command *raise*, raise the forearms until nearly vertical, fingers extended and joined, palms toward each other. UP: Thrust upward with force, extending the arms to their full length. DOWN: Force the arms obliquely back, and gradually let them fall by the sides. Continue by repeating *raise, up, down.*

Seventh Exercise.

1. *Forearms horizontal*, 2. RAISE, 3. FRONT, 4. REAR.

At the command *raise*, raise the forearms to the front, until horizontal, elbows forced back, hands tightly closed, backs down. FRONT: Thrust the arms forcibly to the front, turning the backs of the hands up, arms horizontal. REAR: Bring the arms back quickly to the first position, forcing elbows and shoulders to the rear. Continue by repeating *front, rear.*

Eighth Exercise.

1. *Trunk*, 2. EXERCISE, 3. DOWN, 4. BACK.

At the command *exercise*, raise the hands and place them on the hips, fingers to the rear, thumbs to the front, elbows pressed back. DOWN: Bend the

trunk forward at the hips as far as possible. BACK: Raise and bend the trunk to the rear as far as possible. Execute both motions slowly, without bending the knees. Continue by repeating *down, back.*

Ninth Exercise.

1. *Trunk*, 2. EXERCISE, 3. RIGHT, 4. LEFT.

At the command *exercise*, place the hands on the hips, as in Eighth Exercise. RIGHT: Bend the trunk to the right without twisting it or raising either heel. LEFT: Bend the trunk similarly to the left. Execute both motions slowly. Continue by repeating *right, left.*

Tenth Exercise.

1. *Trunk*, 2. EXERCISE, 3. CIRCLE RIGHT (or LEFT).

At the command *exercise*, place the hands on the hips, as in Eighth Exercise. CIRCLE RIGHT: Bend the trunk to the right as in Ninth Exercise; turn the trunk to the rear and bend to the rear, as in Eighth Exercise; turn the trunk to the left and bend to the left, as in Ninth Exercise; turn the trunk to the front and bend forward, as in Eighth Exercise. Continue by repeating *circle right.*

Eleventh Exercise.

1. *Arms vertical, palms to the front*, 2. RAISE, 3. DOWN, 4. UP.

At the command *raise*, raise the arms from the sides, extended to their full length, till the hands meet above the head, palms to the front, fingers pointed upward, thumbs locked, right thumb in front, shoulders pressed back. DOWN: Bend over till the hands, if possible, touch the ground, keeping arms and knees straight. UP: Straighten the body and swing the arms, extended to the vertical position. Continue by repeating *down, up.*

Twelfth Exercise.

1. *Arms forward, palms down*, 2. RAISE, 3. DOWN, 4. UP.

At the command *raise*, raise the arms to the front, extended to their full length, till the hands are in front of and at the height of the shoulders, palms down, fingers extended and joined, thumbs under forefingers. DOWN: Bend the trunk forward at the hips as far as possible, and swing the arms backward, knees and arms straight. UP: Straighten the trunk and swing the arms to the forward position. Continue by repeating *down, up.*

Thirteenth Exercise.

1. *Leg*, 2. EXERCISE, 3. *Half bend*, 4. DOWN, 5. UP.

At the command *exercise*, place the hands on the hips, as in Eighth Exercise. DOWN: Lower the body, separating the knees and bending them as much as possible, heels on the ground, head and trunk erect. UP: Raise the body, straightening and closing the knees. Continue by repeating *down, up.*

Fourteenth Exercise.

1. *Leg*, 2. EXERCISE, 3. *Full bend*, 4. DOWN, 5. UP.

At the command *exercise*, place the hands on the hips, as in Eighth Exercise. DOWN: Lower the body, separating the knees and bending them as much as possible, head and trunk erect, heels raised, weight of body resting on the balls of the feet. UP: Raise the body, straightening and closing the knees, and lower the heels to the ground. Continue by repeating *down, up.*

Fifteenth Exercise.

1. *Leg*, 2. EXERCISE, 3. *Left* (or *right*), 4. FORWARD, 5. REAR, or 5. GROUND.

At the command *exercise*, place the hands on the hips, as in Eighth Exercise. FORWARD: Move the left leg to the front, knee straight, so as to advance the foot about fifteen inches, toe turned out, sole nearly horizontal, body balanced on right foot. REAR: Move the leg to the rear, knee straight, toe on a line with the right heel, sole nearly horizontal. Continue by repeating *forward*, *rear*.

When the recruit has learned to balance himself, the command *forward* is followed by GROUND. Throw the weight of the body forward by rising on the ball of the right foot, advance and plant the left, left heel thirty inches from the right, and advance the right leg quickly to the position of *forward*. Continue by repeating *ground* when the right and left legs are alternately in the position of *forward*.

Sixteenth Exercise.

1. *Leg*, 2. EXERCISE, 3. UP.

At the command *exercise*, place the hands on the hips, as in Eighth Exercise. UP: Raise the left leg to the front, bending and elevating the knee as much as possible, leg from knee to instep vertical, toe depressed. UP: Replace the left foot and raise the right leg, as prescribed for the left.

Execute slowly at first, then gradually increase to the cadence of double time. Continue by repeating *up* when the right and left legs are alternately in position.

Seventeenth Exercise.

1. *Foot*, 2. EXERCISE, 3. UP, 4. DOWN.

At the command *exercise*, place the hands on the hips, as in Eighth Exercise. UP: Raise the body upon the toes, knees straight, heels together. DOWN: Lower the heels slowly to the ground. Continue by repeating *up*, *down*.

All of these should not be executed in succession. In fact, a rest of a few moments should be taken after doing any one of the exercises ten times, and it is never necessary to go through the whole seventeen at one time, four or five comprehensive ones being often sufficient.

SPECIAL INDOOR EXERCISES FOR GIRLS.

In the case of girls, it should be said at the start that an instructor is almost necessary, and they are so easily obtained that I should unhesitatingly advise that all girls should be put under the care of one, whether at school or elsewhere, almost as soon as they are old enough to go to school at all; for it is quite impossible to estimate the good derived from light, simple, quiet, regular physical exercise, such as is furnished either in the Delsarte or the Swedish system for girls between the ages of four and twenty. There will soon not be a school, private or public, in the United States that will not put all girls through some form of special-development

exercises. Then people will look back with wonder at the time when school teachers and superintendents were so short-sighted as to allow physical exercise to be slighted. In the meantime whatever exercise is taken should never be anything violent; no weights over a pound or so should be used, and, if nothing else offers, there is always the home training at hand. In fact, one of the best sights in all the field of physical training is to see a little girl in her gymnasium suit going through a carefully studied routine of short exercises with her mother, morning and night; and when one thinks how many doctor's bills, how many hours of sleeplessness and pain, can be saved her—both of them, in fact—by this quarter of an hour morning and night, it seems marvellous that it is not a more general custom.

TRAINING.

In the process of discussing outdoor and indoor games and special exercises I have used the word "training" many times synonymously with exercise. This is a popular custom, and is perhaps correct. Strictly speaking, however, training means more, and the title of this article signifies something more than development exercises. It includes this, and includes also the daily life of the person taking the exercise, his manner of eating and the things he eats, his general plan of life from day to day, the time of rising and retiring, the hours of sleep, the dress, and the arrangement of all these for regular life or for some coming contest. It is not my purpose to enter here into a discussion of the proper food for different individuals. I merely give below a sketch of the general subject of training, which includes as one part exercise, as another food, and so on.

Two Kinds of Training.

Training for a contest is quite different from training for general health in the ordinary walks of life. Contests are not ideal health preservers by any means. As has been already said, they could be readily dispensed with theoretically, but practically we should have little or no athletic life in the community if a match of some kind was not either indirectly or directly in view in most cases. There are probabilities that the young man may injure himself at football or polo. People have permanently disabled themselves by playing tennis. Many a man bears the mark of his baseball days, and all these and many more casualties are to be found in most personal-contact games. While, therefore, there is reason in the objection made by parents and others that the sports of children are dangerous to life and limb, the same parents should keep in mind the benefit only to be derived from such games, and they should distinguish between serious injuries and the commonplace knocks of childhood and youth. There is born with every vigorous boy or girl a natural and commendable desire

to surpass others, to win what is worth having, and the harder the struggle becomes, the more pleasure and glory there is in the victory. Such desires are not only natural, but necessary. They are the springs that force the world and civilization forward, and he is but a despicable youth who does not feel them stirring within him. Like everything else, they may be carried too far; but this does not make them useless nor oblige us to discourage them. I should regret the want of them in a child or a friend of mine, and if a careful canvass of the community were made there is little doubt that we should find every one of the same opinion.

Value of Contests.

Contests, then, with all their faults, are valuable—nay, necessary. And this for two reasons: while they stimulate the individual to practise faithfully for his coming match, teach him thoroughness and discipline, they also furnish a standard for the community and the country, constantly raising it, and inducing many a person who might never think of exercising otherwise to do so merely in emulation of those who succeed so well. One can, for instance, hardly deny that American yachting has received a most extraordinary stimulus directly from the international yacht races of the last ten years. It would be as difficult to deny that intercollegiate athletics have increased the general practice of athletic exercise among students, even among hosts of men who never hope or care to belong to 'varsity teams. This has now grown to such perfection that schoolboys all over the country are actually studying the science of physical exercise under able instructors solely in emulation of college athletics, induced by intercollegiate contests.

To prepare for one of these contests, a far different method must be employed when nothing more than the maintenance of health is the object of exercise.

Training for Contests.

First of all, sleep is more necessary, because the individual is under greater nervous strain and is taking more exercise. For a boy or man preparing for any personal-contact game eight hours is the minimum of sleep, and nine is far better. This sleep should be between 10.30 at night and 7.30 in the morning. The individual should retire at ten and breakfast at eight, and the more regular he is in keeping exactly to these hours the better will be his condition. Most races or matches are won by the man who has the greatest powers of spurting and endurance, depending, of course, on the sport. That is, any one can, with a little study, run a race and come in a good third. Many can run neck and neck with a trained runner until the last lap or the last ten yards; but the power to outdo himself in the last stretch, to add to his speed at the last moment, is only obtained by the man who puts his body into such admirable condition that it responds to the added strain easily and quickly, who keeps his digestion in such good condition that there is no weakness there at the critical time.

Indeed, though it may seem of the earth earthy to say it, courage and will-power depend a great deal upon digestion. An army will fight better after eating than before, for many a man is braver with a full stomach than an empty one.

That, however, does not mean that an athlete should go into the mile run just after dinner. Far from it. After rising at 7.30 he should take a plunge bath, if possible; if not, a sponge or shower in cold water—not the cold water of winter, but water at the temperature of the air during about eight months of the year, which can be tempered during the other four by a little warm water. Breakfasting at eight, he should then go about his regular work. Taking the college man as the example for the moment, he should go to his studies or recitations. At one o'clock comes luncheon, and then more work. At three he should go to the gymnasium and dress in his running suit. Suppose he be a contestant in the mile run: He dresses in costume already described and goes out on the track. For an hour he practises at the details of the exercise prescribed for long-distance runners, and, while not hurrying, he never stands about listlessly, doing nothing but catching cold. At the end of the hour he may start out on a two- or three-mile jog. At any rate, by five or later he returns to the gymnasium warm, perspiring, tingling all over, and goes at once into the shower bath, first warm and then cold. A careful and complete rub-down follows by one of the gymnasium rubbers; and then dressing, the mile runner walks over to his dinner at six o'clock. In the evening he does not stand out of doors, but, if he goes out at all, he remembers that after such exercises and such a bath one may easily take cold, and he accordingly has a care as to his dress. By ten he is ready to go to bed, and by eleven, at the latest, he is asleep. While this is training for athletics in a manner not possible to one whose day is occupied with other matters, it nevertheless sets a good standard for those who wish to give themselves as much physical training as is possible.

Food.

A word as to food. Much has been said and written as to training-table food—from the "raw-meat" diet down through the gamut to the eating-anything-you-like theory. Both are wrong. The average college athlete, when in training for a severe contest, such as football, eats for breakfast oatmeal, or rice, or hominy, dry toast, steaks or chops and eggs, boiled or mashed potatoes, perhaps a little tea or milk, and drinks as much water as he wants. For lunch, toast, steaks, chops, chickens, or birds of any kind, boiled or mashed potatoes, perhaps some simple vegetable, such as stewed tomatoes, prunes, rice and milk, with milk and water to drink. For dinner, plain soups, roast beef, lamb or mutton, turkey or chicken, simple vegetables and potatoes as described, toast, milk or water, plain puddings, such as rice or tapioca, and occasionally ice cream. This is simple fare enough, and within the

reach of every one, whether in or out of college. The most important part is in the cooking, for all the viands should be well and thoroughly cooked, though not dried up. It will be noticed that nothing fried is eaten by men in training, that nothing is highly seasoned, and that there is no great variety in the food. Almost everything furnishes solid tissue, and nothing adds fat to the system, though all these articles are easily and quickly digested. For any boy or man who is working from two to four months to prepare himself for some contest in baseball, football, tennis, rowing, track athletics, or lacrosse, this skeleton of a training-table diet is good; but to follow it religiously and eat between meals, sleep only after twelve at night, or do anything else contrary to the rules set down, is as bad as to "break training" at the table whenever the spirit moves.

Stimulants.

Stimulants at the training table are sometimes prescribed by trainers. Often men who have lost appetite and weight, who lose their nerve and grow moody and melancholy—become "overtrained," in other words—are given ale, or claret, or an egg in sherry once or twice a day. If a man trains correctly, however, and does not exercise beyond his powers, he will not overtrain, and hence it is unwise to give him stimulants. For a perfectly healthy man liquors of any kind are silly. You can not put vigour and courage into a player by dosing him with alcohol. I remember seeing it tried once. A football player had been ill, and should not have played when he did. He was necessary to the team, however—or so, at least, thought the captain—and he was dosed with cocaine wine. He played well for half an hour, and then began to feel ill again. He was given more cocaine wine. Twenty minutes afterward he stopped playing for a moment, and the next thing he knew it was four hours later, and he found himself in bed with a doctor feeling his pulse and trying to bring him to.

Training for Health.

Training for the ordinary exercise of a business man or woman who does not look forward to any contest is quite a different affair from training for some athletic contest. The principle is practically the same—simple, easily digested food—but it should be carried out in a more limited way. In the one case, a college man training for a match is permitted to eat about as much as he wants. The sedentary life of the latter makes it wise for the individual to avoid eating too much, or too many vegetables, but at the same time the monotony of his bill of fare can be varied with greater latitude than in the stricter contest training. Fried foods are bad for both, however, and should be avoided. The business man does not need, nor can he usually take, as much sleep. Seven to eight hours, according to the person, is usually enough, and there is not the absolute necessity of retiring so early as in the student's case. If a man can do his work better in the evening than early in the morning, there is no reason why he

should not retire at twelve or later, and rise at eight, provided he can sleep soundly until that hour in the morning. Busy men often acquire the habit of sleeping fifteen minutes to half an hour during the day, or just before the evening meal; and this, if the slumber be sound, is a remarkable rest both to mind and body. Such people, rising at eight and breakfasting between half-past eight and nine, if not earlier, should either put themselves through the fifteen-minute exercises already described, or lay out in the afternoon some one hour to be devoted to the playing of a game. Then follows breakfast, the lighter the better, often consisting of oatmeal or hominy, coffee, eggs, and toast, or perhaps a small amount of meat. Lunch at noon or a little after, and at six or later, after the hour at rackets or tennis or running, riding, rowing, or what not, a hearty meal. Smoking among students or men training for contests is a mistake. It not only affects the "wind," but relaxes the nerves in a way to make them less vigorous for the coming contest. It is not that it is an injury, or an important feature of training; but, like fried foods, it shows its results at once, and where the athlete is trying to do his best to win he will do well to avoid it. Try to walk up a long hill while smoking a cigar, and you will soon see what smoking can do to make you uncomfortable. In the case of a business man, if smoking in moderation does him no harm, there is no reason why he should stop it. Every one is, however, inclined to overdo it, unless he has some limit, and one of the safest of these is to make a rule not to smoke until after the six-o'clock dinner. Constant puffing at a cigar brings no pleasure. One merely misses it when one stops. Indulged in occasionally, smoking is a pleasure, a rest, and a recreation, and as such there is no reason why it should be discontinued, providing it does no injury to the individual.

The business man should take his plunge bath and rub himself down every morning after rising, breakfasting at once after dressing. His lunch should extend over the full sixty minutes. It is useless to hurry through this meal or eat a sandwich at one's office desk, for the work goes no faster afterward, since one can not work as well during the afternoon after such a meal. Then between five and seven there should be an hour out of doors at some exercise as vigorous as the individual can stand, followed by a warm and cold bath and a hearty dinner.

All this is very general. There are many cases where men can not stand two baths—or rather a plunge and a bath—each day. Still others are too stout for games, and others, again, are too slight to live healthfully on a diet composed of such a large proportion of meat. The general rule, however, for a normal man is correct, and each person must regulate his particular day according to his own body, as well as according to his own conscience, besides securing the aid of his physician to help him.

CONCLUSION.

It may not be out of place, therefore, to close this article with a suggestion of a plan for the daily life of men and women of different ages, which will in a measure be hardly more than a recapitulation of what has already been said.

Age, Sex, and Condition.

Nothing more specific to apply to all cases can be suggested here than has already been mentioned, and it must be understood that each person must mould that particular form of exercise which comes nearest to his or her needs in order to make it fit his or her particular case. There are, nevertheless, certain well-marked divisions. Men and women need different forms of exercise; so do boys and girls. Men of the city require quite different development exercises from farmers, society women from farmers' wives, city girls from country girls, and schoolboys from boys of the plains. In all these it must be borne in mind that each and every muscle is to be used, and that each and every day's practice is to be followed by a bath.

Clothing.

In the first place, clothes have a great deal to do with training. The individual, rising in the morning at his regular hour, should, after bathing, put on absolutely dry clothing. The underclothing should not, in a healthy person, be very thick. Indeed, it is not really necessary to change the thickness of underwear from one year's end to the other, and it is probable that more colds are encouraged by these many changes of material than in any other single way. In winter the house is usually as warm as the atmosphere is in the summer, except on the hottest days. Clothing which is worn all the time, therefore, need not be changed in thickness. The extra warmth necessary for the cold winter days is to come from overcoats and thick outer clothing, which are worn only in the winter outdoors, and not at all in the summer.

This underclothing should be fresh every day. That entails seven sets a week, and though the average person thinks this is extravagance at first, it is not so in reality. It is not only a much more healthful method, but this, combined with the daily bath, is an extraordinary rest to a hard-worked body. If seven changes a week are considered impossible, the man may have two sets in use, one for the day and another for the evening; but in any case the thing to avoid is putting on clothing not thoroughly dry after you have taken exercise, or in the morning after rising.

The following suggestions will explain themselves. They are different schemes for informal but healthful exercise for different types. This list might be far more complete, but the method employed in this article has not been so much didactic as suggestive, and, furthermore, there is

not space at my disposal to go into the matter more thoroughly. For a man occupied with city work, who can not get outdoor exercise, the following suggestions might be made, it being understood that the exercise takes place somewhere between five and seven at night, and occupies an hour:

Specific Lists for Exercising.

For the City Man.

In a gymnasium, either (1) play rackets or court tennis, ending up with Indian clubs, especially with the left hand; or (2) play handball, ending with the mile run around the gymnasium track; or (3) spar with the instructor half an hour, including rests, then jump or wrestle, and end up with a mile run around the track; or (4) give a few minutes each to the high jump, the parallel bars, Indian clubs, punching bag, and run a mile—in all an hour's work; or (5) distribute the above through the week—that is to say, take up number 1 on Monday, 2 on Tuesday, 3 on Wednesday, 4 on Thursday, and then begin again, or make up a fifth and sixth scheme for exercise as different from these and each other as are the above. There will thus be different schemes for exercise for each day in the week.

If the gymnasium is impossible, set aside fifteen minutes at morning and at night, and either (1) go through the army setting-up exercises, giving each of the movements ten repetitions; or (2) prepare the "home gymnasium" after the manner already suggested, and make out a routine from the apparatus at hand equal to the setting-up exercises, as, for example, a few minutes each on the horizontal bar in the doorway, punching bag, rowing machine, Indian clubs, and parallel bars in the window; or (3) use light dumb-bells and go through some of the movements, as suggested in the earlier pages of this article.

For Country and Suburban Life.

A man who works outdoors in the country should take exercise for straightening his body and for opening his lungs, since most employments connected with work in the country involve stooping and development of the shoulders and back at the expense of chest muscles and lung power. For such occupations there is nothing better than the army setting-up exercises and those house exercises which open the chest, tend to throw the shoulders back, and exercise the arms. A suburbanite, on the other hand, should invariably take up outdoor exercises. He is in the country, and can join a country club. Tennis, therefore, golf, perhaps baseball, possibly bicycling carried out in moderation, are the kinds of exercise he needs. In other words, the farmer works outdoors and needs quickness, erectness, vivacity. For him special development exercises are necessary. The suburban resident works in the city, but lives in the country. His exercise should be, therefore, out of doors.

For women in the city life is unnatural enough, but there is much that can be done in the way of exercise if they will only give the time to

it. Every such woman should either join a gymnasium, or, if the necessary funds are at hand, ride horseback, or have her own home gymnasium. She should either (1) ride from a half to three quarters of an hour a day on an easy, quiet horse in parks or suburbs, and at the same time go through the development exercises already mentioned; or (2) join a woman's gymnasium and put herself under an instructor in the Delsarte or Swedish systems, exercising at this three times a week at least, or not more than an hour at a time. Here, as elsewhere, however, the slightest feeling of weariness should be the sign for stopping exercise; or (3) set aside an hour in the late afternoon, and walk three or four miles through parks or the neighbouring country at a quick, vigorous gait. There is no question that most women, if they really want to do this, can find the time for it; or (4) study out the army setting-up exercises and make selections from the list, repeating six or seven times half a dozen of the most distinct movements, especially those developing the chest. This should be done before going to bed at night and just after rising. These exercises are usually supposed to be for men, but man never made a greater mistake than in thinking that the woman who bore him could give him a vigorous body if she were physically weak herself. There may be cases where strong children have come from weak parents, but it is strictly and practically true that the "strength of the mothers of the nation makes the strength of the nation itself." It is unfortunate that we can not give more space to woman's physical training. Perhaps some student of physical health will some day write a book on physical training for women, and then I, for one, shall recommend it to all men and women.

For City Women.

For women who live in the country, the best exercise is riding, or playing some game at regular intervals and for short spaces of time out of doors. They should join all the country clubs they can, play tennis or golf, walk, skate, and row; but they should do all these, except, possibly, golf and riding, alone or with other women, and not with men, for the reasons already mentioned.

For Women of the Country.

It is impossible to do justice to children here. Their exercises should be the study of parents. They should be kept in the open air, in the sun during both cold and hot weather, and brought up with the idea that it is necessary that they should take some little exercise each day so impressed upon them that they will never forget it. Daily baths, fresh clothing, short, vigorous, systematic exercises at regular times, will do much, not only to make them healthy, but to make them quick in their studies and well supplied with common sense. All children's exercises should be in the form of games in every conceivable instance.

Children.

Let me say, as a last word, that if all the mothers were thorough physical exercisers, and if all their children were brought up to take regular exercise daily, we should have the United States filled with a fighting race of men and a fine, womanly, healthy race of women. As Mr. Carlyle might have said, it only needs "an infinite capacity for taking pains" with your little simple daily exercises. Only in this instance it would be enough if the capacity were merely finite instead of infinite.

V.

HYGIENE.

By SAMUEL TREAT ARMSTRONG, M. D.

INTRODUCTION.

Definition of Hygiene.

Hygiene is the science that has for its object the preservation of health and, as a corollary, the prevention of disease. On the latter account it is often termed *preventive medicine*, to distinguish it from the other branches of medical science that are devoted to the treatment and cure of disease.

In the course of time experience teaches us the verity of the old adage, "an ounce of prevention is worth a pound of cure," but we are not always informed when and where the prevention may be best applied. The conditions of life have changed so essentially during the past half century, so many inventions and discoveries have been made which have for their object the furtherance of business or comfort, but often without consideration of their influence on health, that it is necessary for us to be aware of their dangers and be cognizant of the best methods of avoiding them.

Life and Death.

Almost a century ago the French *savant*, Marie François Xavier Bichat, whose investigations materially assisted in creating the science of physiology, said that *life is the consensus of the functions that resist death*. While death can not be ultimately avoided, recent discoveries have proved that many die prematurely, and that such mortality is the consequence of the faulty hygienic arrangements of cities, of houses, of food, and of water supply. Daily there are adventitious and avoidable factors that are affecting and involving the functions that resist death, and this is true notwithstanding the fact that the mean duration of human life has increased. The general adoption of vaccination, the improved character of municipal water supply, the inspection of food stuffs and the greater variety in dietaries, the isolation of patients with communicable diseases, have served to diminish the prevalence of sickness.

It is a fundamental assumption with the citizens of America—an

assumption that is entertained by the inhabitants of all civilized lands—that men have an inalienable right to life, liberty, and the pursuit of happiness. But life itself is not worth living to one who is afflicted with some chronic disease; there is no liberty when disability or infirmity incident to sickness limits all effort; and the pursuit of happiness is a figment of the imagination to the sufferer. Modern research has proved that in a last analysis the old Romans were right when they spoke of a sound mind in a sound body.

Causes of Disease: Object of Hygiene.

Slight perversions of the functions of the human organism suffice, when unrelieved, to produce disastrous mental and physical aberration; for the organism, in health as well as in disease, is a receptacle and laboratory of poisons that are received in the food, created by bad assimilation, and formed in secretions. As Prof. Charles Bouchard has said, man is living constantly under the chance of being poisoned; he is always working toward his own destruction, his own suicide, by intoxication due to products he creates within his body. These injurious substances may, in people who are in good general health, be produced superabundantly or destroyed insufficiently, in consequence of excesses, late hours, mental anxiety, or as a result of the influence of dampness, cold, or dwelling in places that are badly ventilated and badly lighted; all of these causes affect the body by first acting upon the central or the peripheral nervous system. Besides these causes of disease that are innate in the individual, there is a predisposition to certain diseases in consequence of heredity and of individual peculiarities. Then there are the extrinsic causes of disease, either physical, mechanical, chemical, or bacterial. Some of these causes may be restricted and controlled, and it is the object of hygiene to determine what are the factors which produce disease, and what is the prevalence of a disease; from these data it is possible to determine the methods which must be adopted to avoid or to prevent this production or prevalence.

Pathogenic and Non-pathogenic Micro-organisms.

The article on *Diseases in General* will indicate the specific organisms that are the cause of disease, or pathogenic, and the micro-organisms that are non-pathogenic. It will be seen that these latter play a very important rôle in disintegrating higher organic bodies into lower compounds; that they are omnipresent in the air we breathe, the food we eat, and the water we drink; that they exist in the soil, in the vegetation of the fields, and in the trees of the forest; that were it not for their offices life would probably be impossible. It will also be seen that the pathogenic micro-organisms gain entrance into the body by the digestive or respiratory tracts, or through certain mucous membranes or the skin; that their entrance is materially assisted by the existence of lesions of

these parts; and that they may remain restricted to the site of infection, or they may develop within certain particular tissues of the body.

Susceptibility to and Immunity from Infection.

There are some facts, however, that bacteriology does not explain and that must be noted. For example, the bacillus that produces diphtheria has been found in the secretions of the nose and throat of healthy persons; so with the coccus of pneumonia and with other pathogenic micro-organisms. This being true, it is evident that some other factor must exist in order that a specific microbe may produce its disease. If a person in good health, in whom some such organism exists, is exposed to any influence that lowers his resistance, so as to permit the introduction into the tissues of the germ or of the poisonous principles (toxines) that it produces, then the disease ensues. But many paradoxical facts have been noted in regard to this subject.

A child is susceptible to many diseases during infancy, such as whooping cough, diphtheria, scarlatina, etc., yet if it escapes an attack of any of these diseases at that period of life it is less likely to become infected therewith in adult life. Or two children almost of the same age, having the same parents, living in the same environment, having to all appearances similar constitutions, are exposed to the same infective disease and one is affected while the other escapes, or one recovers quickly while the other has a protracted or even fatal illness. These facts are as inexplicable as the reason for one animal being indifferent to a microbe that is rapidly fatal to another animal of a different species; but there is a fundamental truth that can not be lost sight of, and that is, that *in a healthy human organism there is a power, independent of extrinsic remedial agents, that disposes of the germs of disease, and that this power can best be conserved and developed by the best hygienic conditions.* This expression must not be understood as a pessimistic view of medicine, for the medical man of to-day is far from deserving Voltaire's criticism that a physician is a person engaged in pouring drugs, of which he knows nothing, into a body of which he knows less. Rossbach has said mankind has endeavoured for thousands of years to discover specific remedies for diseases, and the result has been the discovery of but four remedies for three diseases; and while the idea that it would be necessary to wait several thousand years more to detect four other remedies would be distressing, our knowledge of the fact that almost two thirds of mankind die of diseases caused by germs, and our increasing knowledge of the various features pertaining to the growth and multiplication of these germs, leads us to infer that it will not be necessary to discover remedies, but rather measures to further the best development of the individual and to restrict all that is inimical to such development.

In the effort that has been made to surround the individual with all

the precautions that may avert or cure disease and conduce to longevity, and in the multiplication of hospitals, the invention of new medical and surgical procedures, and the general endeavour made to patch up diseased and infirm individuals, some critics have discovered misdirected effort that interfered with the processes of Nature in eliminating the unfit—that is, a class unable, through physical or mental infirmity, to support themselves or to contribute to the general welfare. The statistics of hospitals and asylums have been pointed to as affording evidence of an increased demand upon their resources, and it has been said that too often the surgeon has saved a life that was neither useful to itself nor to humanity. So, it has been alleged, has the physician striven to nourish and preserve the lives of children whose infantile ailments proved the existence of a deteriorated physical and mental endowment, and who, as they developed into maturity, would evidence abnormal mental as a consequence of abnormal physical conditions. These "stepchildren of Nature," as they have been called, comprising the constantly increasing defective class, are the products of centuries of faulty conditions. That man is his brother's keeper is beyond dispute; and for all the wrongs that erroneous hygienic measures have imposed upon humanity society is responsible and must atone for. Complaints are constantly and universally heard in reference to increased expense to the community for the maintenance of the classes herein referred to. The investigations of the bacteriologist have shown the truth of the psalmist's words, that the pestilence walketh in darkness, for all the pathogenic micro-organisms thrive best in least light, and the researches of the hygienist and sociologist have shown that the pestilence of the defective class is best developed in the dark, squalid, ill-ventilated homes and in the ignorance of the working classes—conditions that are too often fostered by the greed or indifference of landlords and by the rapacity of employers.

Survival of the Unfit.

CHAPTER I.

VITAL STATISTICS.

To determine the prevalence of any particular disease, which is a preliminary necessary to the study of the means by which it is to be restricted or prevented, it is necessary to have recourse to a system of vital statistics. From properly collected statistics we deduce facts in relation to the sanitary life of the individual, of the community, and of the State. Such statistics

Need of Vital Statistics.

should afford trustworthy data for determining the expectation of life of each newborn child; for indicating the diseases to which the child would be most liable in its growth to manhood; for correcting faults in the construction and arrangement of dwellings, by the permanent record in the office of the Board of Health of the sanitary history of each house in a community, so that it would be as feasible for an intending tenant or purchaser to search its sanitary record as it is for him to search its title in the office of the Register of Deeds. Such statistics should indicate the efforts that must be made by the sanitary authorities in the correction of faults in their inspection service and in their methods of segregating communicable diseases, and in the remedying of errors in the drainage, sewerage, and water supply. By such means it would be possible to learn whether a house, a group of houses, a district, a ward, a town or city, a county or a State, was in a better or worse sanitary condition than a corresponding house or community.

Materials for Vital Statistics.

The materials necessary to make such investigations include records of births, deaths, and sickness, as well as *accurate census returns taken at regular intervals.* On the last will depend the utilization of the preceding. In America, as in many countries, a national census is taken decennially, while in many communities a local census is taken quinquennially. Population either increases, decreases, or remains stationary, so that between the first and the tenth, or even the first and the fifth year of a census period there is a variation in the number of inhabitants. The increase may be due to a constant excess of births over deaths, as well as to immigration; the decrease may be due to an emigration that offsets any excess of births over deaths, or the latter factor may be reversed; and the stationary condition may be due to the fact that there is neither immigration nor emigration, and the births and deaths balance each other; or if there is immigration, that there is a decreased birth-rate or increased death-rate, or both; or if there is emigration, that there is an increased birth-rate and decreased death-rate, or both.

How to estimate Increase of Population.

The annual increase of population between census periods is ascertained by the following method: Let P and P′ represent the enumeration in 1880 and 1890 respectively, assuming that the increment in every year is one tenth of that recorded in ten years, the annual increase is obtained by subtracting P from P′ and dividing the remainder by ten $\left(\frac{P' - P}{10}\right)$

A better method is to take a table of logarithms and subtract the logarithm of the previous from that of the last census, and divide the remainder by the number of intervening years, and the quotient will be the logarithm of the ratio of annual increase.

To find the population of any one year, multiply the latter logarithm by the number of years elapsed since the census, add the product to the logarithm of the population, and then by reference to the tables the number that this sum represents may be obtained.

How to find Population of a Given Year.

While such mathematical estimates are fairly accurate for very large populations, as those of a nation, they are liable to error in proportion to the smallness of the number that is dealt with. If the assumed differs from the true population by ten per cent., an assumed death-rate of twenty-four per thousand will represent an actual rate of 21·6 or 26·4, in accordance with the fact that the difference is an excess or a diminution. It has been a frequent experience that the mortality rates of American cities have been erroneous in consequence of overestimation of the population, such overestimation having been made on account of a desire to increase the prosperity and importance of the place, as well as to show salubrity and efficient sanitary supervision. England has had a similar experience, population having been overestimated as much as thirty-three per cent. The census of 1900, like its predecessors, will undoubtedly show that not a dozen cities base their mortality rate on a correct estimate of population.

Trustworthiness of such Estimates.

In determining the population it is desirable to know how many inhabitants there are in certain areas, how many of each sex, of each group of ages, and of each occupation, for all of these influence the tendency to sickness and death.

The number of inhabitants in certain areas is known as the density of population. In the United States in 1790 this was 4·75 per square mile; in 1810, on account of the increase in area resulting from the purchase of the Territory of Louisiana, the density had decreased to 3·62; but every decennium since that year there has been an increase, until in 1890 the density was 20·70. But this density is not evenly distributed. In 1790 the population in the cities was 3·35 per 100 of total population, while in 1890 it was 29·20 per 100 of total population, or an increase in density in the cities from one thirtieth to one third of the population. So in other countries there is this increase in urban population; in 1801 London contained one eleventh of the population of England and Wales, and in 1890 it contained one seventh of the entire population of those countries. The density in the United States is small in comparison with that of other countries. In England and Wales the last census returns showed that there were 503 persons to the square mile; in Ireland, 144; in Scotland, 138; while in more recently settled countries the proportion is less than here, as in Victoria there are only 13 to the square mile; in New Zealand,

Density of Population.

6; in Tasmania, 5·5; in New South Wales, 3·5; and in Queensland, 0·5 person to the square mile.

Coincident with this increase in the population of cities was an increase in the number of persons in a dwelling, although in the entire country there was a slight decrease. In 1850 the average for the United States was 5·94, in 1880 it was 5·60, and in 1890 it was 5·45 persons in a dwelling. But in New York city the average had increased from 16·37 in 1880 to 18·52 in 1890; in Brooklyn it had increased from 9·11 in 1880 to 9·80 in 1890; and in Chicago the increase was from 8·24 in 1880 to 8·60 in 1890. In the latter year 50·18 per cent. of the dwellings in New York city contained from one to ten persons, and 49·82 per cent. contained more than ten persons; but the latter proportion represented 83·50 per cent. of the population, while the former represented 16·50 per cent. In Chicago 75·46 per cent. of the dwellings contained from one to ten persons, equal to 50·82 per cent. of the population of that city, and 24·54 per cent. of the dwellings contained more than ten persons, equivalent to 49·18 per cent. of the population. In Philadelphia 95·61 per cent. of the dwellings contained from one to ten persons, equal to 87·21 per cent. of the city's population, while 4·39 per cent. contained more than ten persons, or 12·79 per cent. of the population.

This increase in the number of persons in a dwelling implies the multiplication of families therein, and an idea of the crowding of families, with its consequent pernicious destruction of home life and sentiment, in different American cities, may be gained from the following table, taken from the Census Report for 1890:

	Population.	Families to a dwelling.
New York	1,515,301	3·82
Brooklyn	806,343	2·08
Cincinnati	296,908	1·90
Chicago	1,099,850	1·72
Boston	448,477	1·70
St. Louis	451,770	1·51
Baltimore	434,439	1·20
Philadelphia	1,046,964	1·10

Consequence of Concentration.

The consequence of the concentration of population in towns and cities is a deterioration of physical health and a higher disease-rate and death-rate than in rural districts. Crowding favours the development and spread of communicable diseases, and while it is a fact that cities in which there is the least crowding do not show that there is a correspondingly low death-rate, or *vice versa*, yet investigation will generally reveal other detrimental factors that vitiate the advantages gained by domicile multiplication.

BIRTHS.

Births should be registered. In no State or city of the United States is the record of births accurate, though it may be a matter of importance to the individual in order to establish his descent and prove his claim to an inheritance. The census returns of the United States for the year 1880 gave a birth-rate of 30·95, and those for 1890 a rate of 26·68.

Birth-rate.

The statistics of all countries show a slight decrease in the birth-rate during recent years. In the United Kingdom this rate has decreased from 35·0 in 1871 to 29·3 in 1890; in Victoria it decreased from 42·81 in 1860 to 38·07 in 1870, then to 30·75 in 1880, and in 1892 it was 32·54 per 1,000 of mean population; in New Zealand it decreased from an average of 31·2 to 27·8 in 1892.

The number of births does not increase with the number of marriages, and it has been conjectured that the diminution is the result of the increasing desire of married women to avoid the responsibilities of motherhood. Dr. W. Balls-Headley considers that the limitation of families is due to the difficulty with which civilized women bear children normally, and the strain, toil, and expense of rearing families; he has formulated the following interesting table of the number of children to each marriage for a series of years in different countries:

Limitation of Families.

Ireland	5·46	Scotland	4·43
New Zealand	5·25	Holland	4·34
Western Australia	4·82	Victoria	4·22
South Australia	4·73	Belgium	4·21
New South Wales	4·70	England	4·16
Queensland	4·60	Sweden	4·01
Italy	4·56	Denmark	3·55
Tasmania	4·51	France	2·98

While in some countries the marriage-rate is decreasing and in most countries it is stationary, the birth-rate is manifestly decreasing.

DEATHS.

The registration of deaths is much more accurate. The existence of laws making it a crime to bury a corpse without permission from the sanitary authorities have accomplished this result. Death records should include the age, sex, place of residence and of death, the primary and secondary causes of death and their duration, and the time of death of the deceased.

Registration of Deaths.

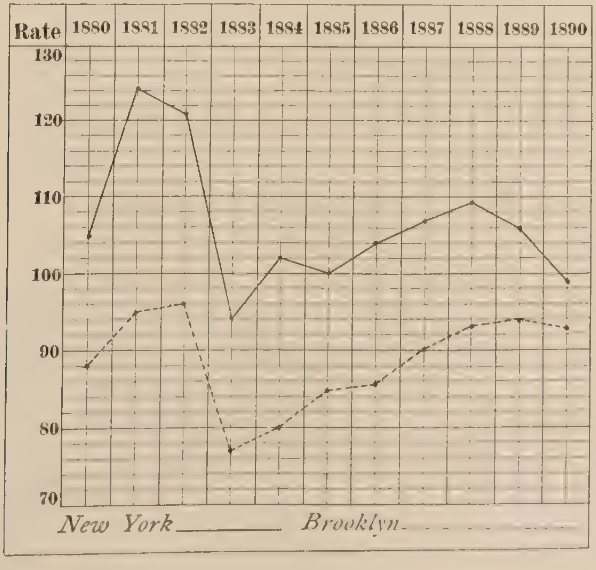
Mortality statistics are considered with reference to the magnitude of the population concerned and to the length of time covered by the record. For convenience it is customary to adopt fixed standards of time and popu-

lation. The rate is expressed as the number that has occurred in each thousand of population during a year, making the rate a thousand per annum. This is roughly calculated by dividing the number of deaths by the number of thousands of population. Thus in New York city in 1890 the census gave a population of 1,515,301, and there were 40,103 deaths; the rate per thousand is obtained by dividing 40,103 by 1,515,301, which gives 26·45 deaths per thousand of population; in that year the Board of Health estimated the population at 1,631,232, which afforded a death-rate of 25·97 per thousand.

How to estimate the Death-rate.

The influence of nativity on the death-rate is shown in the data that the death-rate for native whites in that year was 32·34 per cent., while it was only 23·31 per cent. for foreign whites. This disparity was largely due to the fact that the native white death-rate was increased by the mortality of individuals under fifteen years of age; the mortality of native white children under five years of age was 110·37, for coloured children it was 153·90, and for foreign white children it was 74·28 per thousand of each group during the six years ending May 31, 1890. Such figures suggest matters for investigation, to decide the reasons for the greater mortality among native than foreign-born children or among coloured than white. There are reasons for the existence of such facts, for there must be local and, furthermore, avoidable conditions that make the death-rates of children under five years of age per thousand of population of corresponding ages so much greater in New York than it is in Brooklyn, as shown by the following diagram, adapted from the census report for 1890:

Influence of Nativity.



The influence of public sanitary measures on the death-rate is strikingly shown by the tables prepared by Mr. B. A. Whitlegge from the reports of the Registrar-General of England, though this decrease was limited to the ages below thirty-five years in males and below forty-five years in females; beyond those periods there was an increase:

Influence of Public Sanitary Measures.

Years.	Mean annual death-rates in		
	Both sexes.	Males.	Females.
1841–50.....	22·4	23·1	21·6
1851–60.....	22·2	23·1	21·4
1861–70.....	22·5	23·7	21·4
1871–80.....	21·4	22·7	20·1
1881–90.....	19·1	20·3	18·1

Unfortunately, the collection of similar statistics in the United States is not sufficiently general to afford a basis for comparison with the results obtained by improvements in hygienic conditions in England and Wales.

The tendency to the highest death-rate is in infancy and old age, and the rate is always lower among females than among males. It is higher in towns than in the country, though in the United States the cities have been gaining most in healthfulness, Dr. J. S. Billings states, in consequence of the fact that systematic sanitary work has been carried on in them to a much greater extent than in the smaller towns and villages. The larger urban mortality is mainly due to an excess of deaths in the earlier years of life.

The Highest Death-rate.

In the United States the death-rate per thousand of living population was, in 1860, 12·54; in 1870, 12·77; in 1880, 15·09; and in 1890, 13·98. The former increased rate is not the consequence of increasing negligence of sanitary measures, but rather the result of more complete mortality returns secured by each census. And the diminution noted in 1890 was due, as Dr. Billings has stated, to the returns of that year being more deficient than in 1880. As evidence of this fact it was shown that in a population of 21,093,320 in which there were State registration returns the rate was 20·27 per thousand, while in a population of 41,528,930, returned by enumerators from districts in which there were no returns, the mortality-rate was only 10·79 per thousand, a disparity that is inexplicable by any probable fact. In the cities the rate was 23·58 and in the country 14·99 per thousand; that of males was 20·68 and females 18·62, while that of negroes was 19·57.

The most frequent causes of death are those from diseases caused by bacteria, tuberculosis being first, then pneumonia, diphtheria, heart disease, cholera infantum, enteric fever, malarial fever, and scarlatina. In 1890 diphtheria caused 33·06 deaths per thousand, and in 1880 it caused 52·32 deaths; the rate in cities was 37·70, and in the country, 22·63. Typhoid fever caused in 1890, 32·16 deaths, and in 1880, 30·19 deaths per thousand. Consumption caused in 1890, 121·49, and in 1880, 124·75 deaths per thousand.

The Most Frequent Causes of Death.

TABLE I.

CITIES.	Population. United States census, 1890.	ANNUAL RATE PER 1,000 OF THE POPULATION.				
		1890.	1891.	1892.	1893.	1894.
Altoona, Pa.	35,000	15·3	....	19·8	22·5	14·2
Atlanta, Ga.	65,514	24·6	25·3	24·1	27·1	....
Auburn, N. Y.	25,858	22·1	19·6	18·2	20·1	....
Baltimore, Md.	434,439	23·3	23·1	24·2	15·7	....
Binghamton, N. Y.	35,005	16·0	17·8	19·6	17·8	19·1
Boston, Mass.	448,477	22·9	23·5	24·8	25·9	15·8
Brooklyn, N. Y.	806,343	24·3	26·4	25·6	25·9	22·9
Charleston, S. C.	65,165	27·9	29·0	29·2	27·9	20·9
Chicago, Ill.	1,099,850	19·6	24·3	23·7	24·7	27·2
Cincinnati, Ohio	296,908	22·3	22·3	20·2	19·8	21·7
Cleveland, Ohio	261,353	19·2	12·2	19·8	20·0	18·2
Detroit, Mich.	205,876	18·8	19·3	24·0	20·0	17·4
Erie, Pa.	40,634	....	....	20·4	17·4	19·0
Fall River, Mass.	74,398	22·1	24·3	25·3	23·4	20·2
Galveston, Tex.	29,084	20·4	23·9	24·5	20·8	....
Indianapolis, Ind.	105,436	16·2	18·4	18·8	19·9	....
Kansas City, Mo.	132,716	16·5	12·3	12·4	....	....
Louisville, Ky.	161,129	21·9	19·1	19·4	....	....
Memphis, Tenn.	50,313	26·7	27·9	25·0	21·3	23·0
Milwaukee, Wis.	204,468	17·9	22·9	21·7	21·2	20·7
Minneapolis, Minn.	164,738	14·7	13·7	15·5	13·5	12·5
Mobile, Ala.	31,076	26·5	28·4	25·3	27·2	....
Nashville, Tenn.	76,306	18·8	23·6	20·7	20·2	....
Newark, N. J.	181,830	25·1	28·3	28·1	26·8	25·3
New Orleans, La.	242,039	29·2	28·3	30·9	28·9	28·2
New York, N. Y.	1,515,301	26·6	28·8	29·1	29·4	27·1
Pensacola, Fla.	11,750	20·1	21·8	24·5	20·6	21·7
Philadelphia, Pa.	1,046,964	20·7	22·0	23·1	22·6	19·9
Pittsburg, Pa.	238,617	21·3	24·4	22·7	22·3	20·8
Portland, Me.	36,426	19·9	17·2	21·8	19·8	20·1
Providence, R. I.	132,146	19·2	19·9	22·3	24·6	....
Richmond, Va.	81,388	28·3	26·6	25·2	25·4	21·1
Rochester, N. Y.	133,896	15·8	18·7	20·3	19·3	16·2
St. Louis, Mo.	451,770	18·4	21·0	20·7	20·4	19·2
St. Paul, Minn.	133,156	15·5	15·9	....	....	....
San Diego, Cal.	16,159	10·6	11·7	10·7	9·7	12·5
San Francisco, Cal.	298,997	22·8	23·3	21·7	19·9	20·7
Toledo, Ohio	81,434	16·4	18·1	19·9	18·0	12·5
Washington, D. C.	230,392	23·7	26·0	27·6	26·6	25·4

Mortality of Large Cities.

The mortality in certain of the larger cities of the United States is given in Table I, that has been compiled from the *Weekly Abstracts of Health* issued by the United States Marine-Hospital Service and from the annual reports of boards of health. These rates do not correspond with those contained in the reports of the boards, because the writer has made corrections for population and ignored the estimates made in the reports. In an article on mortality in the appendix to Quain's *Dictionary of Medicine* the instance of Memphis, Tennessee, was cited by the writer as an example of this tendency of overestimation of population; the United States census of 1890 gave the population of that portion of the city comprised within the jurisdiction of the Board of Health as 50,313; but the Board asserted

that this estimate was erroneous, and in 1890, 1891, and 1892 calculated their mortality on an estimated population of 60,000. In 1893, allowing for an increase in population during the three years that had elapsed since the national census, a local census was made that returned a population of 57,951, or more than 2,000 less than had been used to determine the per thousand mortality of the three previous years. A number of Western cities, notably St. Louis previous to 1880, calculated their census on a largely overestimated population. No advantage accrues to a municipality or township from such overestimations, as the inhabitants are erroneously informed regarding their actual sanitary state, and the data published for the information of sanitarians is received with the distrust it merits. Underestimation is infinitely less disadvantageous than overestimation.

Influence of Negro Population.

A factor that exercises considerable influence in producing the high death-rate of the Southern cities of the United States is the large negro population. This race has a lessened resistance to disease, the infant mortality is quite high, and the mode of life is indifferent to all, or almost all, hygienic considerations. Dr. H. B. Horlbeck, of Charleston, South Carolina, collected the following evidence afforded by Southern cities:

Cities.	White, per thousand.	Negro, per thousand.
Charleston, 1880 to 1890	21·39	43·66
Memphis, 1876 to 1890	23·32	29·03
Mobile, 1876 to 1890	22·68	28·73
Nashville, 1875 to 1890	17·91	32·30
New Orleans, 1881 to 1890	23·73	37·87
St. Louis, 1880 to 1890	19·02	34·16
Washington, 1876 to 1890	18·40	33·60

This increased mortality among negroes is not the fault of their environment, for in almost all of our cities their death-rate is much higher than that of the whites, as may be seen in Table II, compiled from the census report of 1890.

Comparison of Vital Statistics.

For the purpose of comparing the vital statistics of cities with those of States and countries Table III is introduced. It is in part adapted from the annual report of the Massachusetts Board of Health for 1893, and in part from the annual reports of the boards of other States. It is to be recalled that the density of population varies in the different countries and States herein included, and the methods of living are also different. Holland and Belgium, for example, are densely populated, and yet their death-rates are markedly less than those of Hungary and Italy, while comparatively sparsely populated Denmark, Norway, and Sweden have quite low death-rates.

TABLE II.

CITIES.	White.	Coloured.	CITIES.	White.	Coloured.
New York	28·47	37·46	Rochester	17·39	6·92
Chicago	21·03	23·30	Providence	21·97	34·81
Philadelphia	22·28	32·43	Indianapolis	17·78	30·04
Brooklyn	25·41	34·99	Alleghany	20·06	24·13
St. Louis	18·15	34·65	Albany	25·34	39·44
Boston	24·62	33·29	Syracuse	19·74	11·53
Baltimore	22·61	36·41	Worcester	19·14	15·37
San Francisco	23·57	24·06	Richmond	22·25	40·80
Cincinnati	21·93	33 04	New Haven	20·90	29·17
Cleveland	21 83	31·63	Paterson	23·62	35·56
Buffalo	19·83	34·22	Lowell	27·42	....
New Orleans	25·41	36·61	Nashville	14·39	23·92
Pittsburg	21·56	29·16	Atlanta	18·28	33·57
Washington	19·79	38·22	Memphis	23·37	29·97
Detroit	20·36	23·45	Charleston	24·75	53·94
Newark	28·67	44·48	Savannah	29·04	41·47
Jersey City	27·48	29·50	Galveston	24·37	25·28
Louisville	19 61	31·98	Mobile	26·05	43·75

TABLE III.

Summary of the Vital Statistics of the Principal Countries of Europe for Twenty Years, and for 1891 and 1892, together with those of some of the United States.

STATES AND COUNTRIES.	1871 TO 1890.				1891.				1892.			
	Marriage rate.	Birth rate.	Death rate.	Excess of birth over death rate.	Marriage rate.	Birth rate.	Death rate.	Excess of birth over death rate.	Marriage rate.	Birth rate.	Death rate.	Excess of birth over death rate.
Massachusetts	18·1	25·7	19·7	6·0	18·9	27·4	19·7	7·8	19·0	27·8	20·6	7·2
Maine	....	....	....	....	....	....	....	....	17·1	21·2	18·4	2·8
New Hampshire	18·6	18·0*	18·9	....	20·6	19·8	19·3	....	21·6	20·6	21·2	....
Vermont	15·6	20·2	15·1	5·1	17·0	20·0	16·9	3·1	17·5	19·7	18·6	1·1
Rhode Island	18·7	23·7	18·0	5 7	18·8	25·9	18·7	7·2	19·4	24·7	20·5	4·2
Connecticut	16·0	23·6	17·1	6·5	16·8	24·8	19·2	5·6	16·6	24·7	19·0	5·7
Michigan	17·5	22·8	9·5	13·2	18·0	23·7	10·3	13·4	18·4	21·2	9·9	11·3
New Jersey †	....	20·0	18·4	1·6	....	20·7	22·1	–1·4	....	20·9	19·8	1·1
Minnesota	....	24·7	11·1	13·6	....	26·1	11·3	14·8	....	....	....	....
Japan ‡	....	26·9	19·5	7·4	....	....	....	....	....	....	....	....
England and Wales	15·6	34·0	20·3	13·7	15·6	31·4	20·2	11·2	15·4	30·5	19·0	11·5
Scotland	13·9	33·6	20·4	13·2	13·9	31·2	20·7	10·5	14·1	30·7	18·5	12·2
Ireland	9·0	24·9	18·0	6·9	9·2	23·1	18·4	4·7	9·3	22·4	19·4	3·0
Italy	15·6	37·3	28·6	8·7	15·0	37·3	26·2	11·1	15·0	36·3	26·2	10·1
Denmark	15·2	31·7	19·0	12·7	13·6	31·0	20·0	11·0	13·6	29·5	19·4	10·1
Norway	13·7	30·7	16·9	13·8	13·2	30·9	17·5	13·4	12·6	29·6	17·7	11·9
Sweden	13·1	29·8	17·6	12·2	11·6	28·3	16·8	11·5	....	....	....	....
Austria	16·3	38·6	30·6	8·0	15·4	38·1	27·9	10·2	15·6	36·2	28·8	7·4
Hungary #	19·1	44·0	33·7	10·3	17·2	42·3	33·1	9·2	....	....	....	....
Switzerland	14·7	29·4	22·1	7·3	14·3	28·2	20·7	7·5	14·7	28·0	19·3	8·7
German Empire ‖	16·4	38·1	26·0	12·1	16·1	37·0	23·4	13·6	15·9	35·7	24·1	11·6
Holland	15·1	35·2	22·6	12·6	14·2	33·7	20·7	13·0	14·4	32·0	21·0	11·0
Belgium	14·2	31·0	21·4	9·6	14·8	29·6	21·0	8·6	15·4	28·9	21·8	7·1
France	15·4	24·6	22·8	1·8	15·0	22·6	22·6	....	15·2	22·1	22·6	–0·5

* For seven years. † For fifteen years. ‡ For ten years.
# Fifteen years. ‖ Nineteen years.

The almost universal decrease in the birth-rate is shown by this table, as well as the uncertain relation between the number of marriages and the number of births.

The Maintenance of Health.

It is now proposed to consider those factors that enter into the preservation and perpetuation of health, whether it be necessary to live in the city or the country. All men incur more or less risk in earning a living, and on a subsequent page the relation of occupation to disease will be considered. But many of the risks of occupations can be avoided; the most frequent causes of mortality should, with our increasing knowledge of bacteriology, be decidedly restricted; and while it may not be possible to realize Sir Benjamin Ward Richardson's sanitary Utopia, with its death-rate of four or five per thousand, involving a mean duration of life of sixty-five years instead of less than forty years, as is the case in the United States, yet the healthier man, living under a healthier environment, will derive more enjoyment from life than he can at present.

CHAPTER II.

AIR.

Definition.

Air is the gaseous envelope surrounding every part of the earth and constituting the atmosphere upon which the existence of animal life depends. It partakes of the rotatory motion of the earth, and its height has been estimated to be from one hundred and ninety-eight to two hundred and twelve miles, although long before these distances are reached the air is so extremely rarefied that it will not support life.

Air is essentially a mixture of oxygen and nitrogen gases, its composition being:

Nitrogen	78·45
Oxygen	20·63
Argon	·04
Carbonic acid	·04
Aqueous vapour	·84
	100·00

The foregoing proportions may vary according to the locality whence the air is obtained. The percentages of nitrogen and oxygen are quite constant, the latter never exceeding twenty-one per cent. even in the country, nor falling below twenty per cent. in the streets of a large city.

Nitrogen is an indifferent gas that has no effect on animal life in such proportions as it exists in air; if a gaseous mixture is made in which a similar proportion of hydrogen is substituted for the nitrogen an animal can live in it.

Nitrogen.

Oxygen is absolutely essential for the support of life, an adult absorbing in twenty-four hours at 32° Fahr., and at mean barometric pressure, more than twenty-four ounces of oxygen. Muscular and energetic persons use more oxygen than less active persons of the same weight; and there is a greater consumption of oxygen in a bright light than in the dark.

Oxygen.

There is an exchange of gases between the inspired air and the blood in the air vesicles of the lungs, the oxygen from the air in the alveoli being absorbed by a chemical process by the venous blood of the capillary blood-vessels of the lung. Physiological investigations have shown that the oxygen diffuses from the air cells into the blood plasma, where it reaches the blood-corpuscles, the reduced hæmoglobin of these takes up the oxygen to form oxyhæmoglobin; in its circulation through the arteries this oxyhæmoglobin comes into relation with tissues poor in oxygen, whereupon the latter is dissociated from the corpuscles and supplied to the tissues, while the blood freed from oxygen returns by the veins to the right heart, whence it passes to the lungs to take up new oxygen.

Animals breathe in a normal way in pure oxygen, the quantity of the latter that is absorbed, as well as the amount of carbon dioxide excreted, being independent of the amount of oxygen present. But if the respired air is deficient in oxygen, prolonged and severe difficulty of breathing occurs, with eventual excitement, spasms, and death. Experiments have proved that animals can breathe quietly an atmosphere containing 14·8 per cent. of oxygen, but in one containing seven per cent. they breathe with difficulty, in one containing 4·5 per cent. there is marked difficulty of breathing, while if the oxygen percentage is reduced to three there is rapid suffocation.

The temperature of the surrounding medium affects the consumption of oxygen. As a result of some yet unknown reflex mechanism, increased cold increases the processes of oxidation within the body, the number and depth of the respirations increase, and more oxygen is taken in. In January, in a temperate zone, a man uses an ounce of oxygen an hour, in July less than an ounce.

Argon is a gas, the discovery of which was reported to the Royal Society by Lord Rayleigh and Professor Ramsay, on January 31, 1895. It forms one two-hundred-and-fiftieth part of the air, and in a year it is estimated that fifty pounds of the gas enter the lungs. It is intimately mixed with nitrogen, and whether it has any influence on respiration has not been determined as yet.

Argon.

Carbonic-acid Gas.

Carbonic-acid gas, or carbon dioxide, arises from the respiration of animals, the decomposition of organic substances, and the processes of combustion. It is produced in such immense quantities that it might be supposed that the composition of the air would vary; but such is not the case, for in the process of vegetation plants decompose this gas, assimilating the carbon and restoring the oxygen to the atmosphere. This cycle of analysis and synthesis pervades Nature. During ordinary respiration more oxygen measured by volume is absorbed than carbon dioxide is given off; for while some twenty-six and a half ounces of carbon dioxide are expired in twenty-four hours, it must be recalled that it is a heavier gas than oxygen, and an equal volume of the latter weighs less than the former gas.

The amount of carbonic-acid gas given off is proportionately greater before the body is fully developed than it is after the bodily energies decay. In young persons the relative amount of oxygen absorbed is greater than the quantity of carbon dioxide given off, and the absolute amount of the latter gas given off is less in children than in adults; but if a calculation is made with reference to body weight, then, weight for weight, a child gives off twice as much carbon dioxide as an adult. After the eighth year males give off more of this gas than females. During sleep the excretion of carbonic acid is diminished almost one fourth in consequence of the absence of muscular activity, abstention from food, darkness, and the retention of heat by the bedclothes. Muscular exercise and the taking of food produce an increase in the excretion of carbon dioxide, while more of the latter is excreted in a bright light or a bluish-violet light than in the dark or in a red light.

In the blood this gas is in combination with the salts of the plasma, and it is so diffused through the walls of the capillaries as to reach the air vesicles, its separation being favoured by the oxygenation of the hæmoglobin in the blood-corpuscles. In air overcharged with carbon dioxide there is difficulty of respiration and eventually death. Breathing in a limited space causes a gradual diminution in the oxygen contained in the air of the apartment, a simultaneous increase in the amount of carbon dioxide, and as the latter accumulates, that formed in the body is not excreted, and eventually there are diminished excitability, lessened temperature, loss of consciousness, and death.

Aqueous Vapour.

Aqueous vapour is always present in the air, varying in quantity, but generally increasing with an increase of the air's temperature. Breathing is most comfortable in an atmosphere that is not completely saturated with aqueous vapour. Air that is too dry irritates the mucous membrane of the respiratory tract; air that is too moist causes a disagreeable sensation, and if too warm there is a feeling of closeness. Therefore it is a matter of importance to be sure that the

necessary amount of moisture is present in the air of sitting-rooms, bedrooms, and hospital wards. The direction of the wind, the season of the year, and the height above sea level produce variations in the absolute amount of moisture; in towns it increases with an elevation and decreases with a diminution of temperature. The relative amount of moisture is greatest at sunrise, least at midday, and is greater in winter than in summer; the air in midsummer contains absolutely three times as much watery vapour as in midwinter, nevertheless it is relatively drier in the former than in the latter season.

Ozone.

In the country and at the seashore the air contains ozone, an allotropic form of oxygen that is rapidly broken up by its tendency to part with one atom of its oxygen to any oxidizable substance with which it comes in contact. It is formed during thunderstorms, and is found in the atmosphere of pine woods. It has a peculiar odour, and its power of liberating iodine from an iodide distinguishes it from the ordinary form of oxygen. When it is present it indicates that there is an absence of oxidizable organic matter, and from this standpoint is considered a criterion of the purity of the air of a locality.

Vitiation of Air.

Air may also contain carburetted hydrogen, carbon monoxide, carbon bisulphide, sulphurous acid, ammonia, organic matter and carbon in towns, and sodium chloride and other salts at the sea shore. Air is vitiated by the respiration of men and animals, by the combustion of fuel and of lighting mediums, by the decomposition of organic matter, and by processes of manufacture.

A healthy adult, at rest, breathes at the rate of from sixteen to twenty-four times a minute; and while the capacity of the lungs varies, about five hundred cubic centimetres of air—something more than one pint, or about 30·5 cubic inches of air—enter the lungs at each respiration. In the course of an hour one hundred and twenty gallons, or seventeen cubic feet, of air are breathed. Exercise or employment increases the number and depth of the respirations, and consequently the amount of air that is consumed. The expired air contains more aqueous vapour, a larger amount of carbonic acid, and organic matters; the quantity of carbonic acid varies from 0·62 of a cubic foot to 1·5 cubic foot in one hour, according as the individual is at rest or is at work. The quantity of organic matter is also dependent upon these two conditions as well as upon the general health, and it is the quantity of this matter, with that which is exhaled by the skin, that so rapidly vitiates the air in a tightly closed room and makes it dangerous to health. The organic matter is of mixed composition, though its nature has not yet been precisely determined; it has a fetid odour, and it is putrescible, oxidizable, and nitrogenous; it is by no means constant in its amount, but it is diffi-

cult to rid an apartment of it. The quantity of aqueous vapour varies with the amount of moisture in the atmosphere and the temperature of the respired air; it has been estimated to amount to from seven to twenty-two ounces in twenty-four hours.

While the standard of carbon dioxide has been placed at 0·6 per 1,000 volumes of air, it may be present to the extent of 2 per 1,000 without producing any very injurious effect on health; but above that quantity it causes headache and other symptoms of malaise.

Modern methods of heating and lighting have diminished the amount of air vitiation due to combustion. The combustion of coal produces carbon, carbon dioxide, disulphide and monoxide, sulphur, sulphur dioxide and sulphuric acid, ammonium compounds, and water; that of wood produces carbon monoxide and dioxide and water; that of coal-gas produces carbon monoxide and dioxide, nitrogen, sulphur dioxide, ammonia, and water; and that of oil produces carbonic dioxide. One pound of coal requires 240 cubic feet of air for complete combustion; an ordinary gas-burner consumes from three to five feet of gas per hour, and each cubic foot of gas requires from five to eight cubic feet of air. An ordinary lamp will consume about 3·2 cubic feet of air in an hour.

The animal and vegetable matters contained in drains, cesspools, sewers, and vaults are subject to fermentation and putrefaction, and produce various gases, fetid principles, as well as animal alkaloids. The characteristics of sewer air will vary with the flushing and ventilation of the sewer.

The gases or dust that are thrown off in some processes of manufacturing contaminate the air to the detriment of the workmen or of the residents of the immediate neighbourhood of the manufactory. Many processes of manufacture, which need not be enumerated, generate poisonous or noxious gases or vapours, the bad effects of which are, as a rule, manifested by a general deterioration of the health of the workmen. The inhalation of dust in manufactures in which metallic or non-metallic, vegetable, animal, or poisonous chemical substances are employed, often causes a thickening of the tissues of the lungs, or the condition of chronic poisoning characteristic of the chemical agent.

Nature of Impurities in the Air.

A variety of substances are suspended in the air; mineral substances, decomposing animal and vegetable matter, and bacteria and their spores, are present in greater or less amounts. In cities the contamination is greater than in the country, and it is greater in large crowded cities and especially in those in which the streets are narrow than in those in which the streets are wide and there is abundant opportunity for the action of sunlight and wind.

The amount of each gas contained in the air is determined by elaborate chemical analysis.

The organic matter is either pulverulent or gaseous. The former may be filtered off by means of glass or asbestos wool, and the latter absorbed by chemical solutions which undergo certain changes in the presence of certain quantities of such gases.

The quantity of dust is determined by aspirating a large quantity of air through thick, dry filters which will retain all suspended matter, and the difference between the weight of the filter before and after the aspiration indicates the amount of solid matter in a certain quantity of air.

The varieties of micro-organisms in the air are determined by exposing plates or dishes containing a nutrient gelatin to the air, or by drawing the air through a tube coated with such gelatin. The microbes grow in the gelatin and form colonies. By making examinations of the separate colonies the varieties and characteristics of the germs are determined. In a quiet room, as in a sewer, the micro-organisms settle down and leave the air comparatively free; and in dwelling-rooms it has been found that their number decreases as the cubic space of, and exposure of the room to, sunlight increases.

The following table, adapted from Sir Henry Roscoe, indicates the relation between the size of the room and the number of micro-organisms, as well as the quantity of organic matter and of carbonic acid:

Cubic Space per Person.	Carbonic acid.	Organic matter.	Total germs.
100 to 180	11·5	2·7	80·0
180 to 260	10·7	2·7	49·0
260 to 340	10·3	2·1	32·0
340 to 500	9·2	1·5	42·0
500 to 1,000	8·6	1·0	6·0
1,000 to 2,500	6·7	0·7	9·1
2,500 to 4,000	7·9	0 9	13·1

It has also been found that the purer the air the more equal is the number of colonies of bacteria and of moulds, while in impure air the micro-organisms increase and the moulds remain stationary in number. Unfortunately, science has not yet determined the micro-organisms of measles, whooping-cough, small-pox, typhus fever, scarlet fever, and chicken-pox, which seem to be particularly likely to be conveyed by aërial means. It has been ascertained that in buildings in which cases of pulmonary tuberculosis have been frequent the air is likely to contain the tubercle bacilli which is coughed up in sputum, becomes dry, and is blown into different corners or crevices by the wind, to be again dislodged by air currents.

CHAPTER III.

VENTILATION, HEATING, AND LIGHTING.

VENTILATION.

VENTILATION is the procedure by which a sufficient quantity of pure air is supplied without perceptible draught; it is an absolute necessity that the air be supplied, and this is more frequently done by ill-fitting windows and doors and the porosity of walls than by special appliances.

Definition; Methods.

Dr. J. Lane Notter has prepared the following table of the number of cubic feet of fresh air required hourly:

	In repose.	In gentle exertion.	In hard work.
Adult males	3,000	4,500	9,000
Adult females	2,000	3,000	6,000
Children	1,500	2,250	4,500

For each gas-burner there should be an allowance of from 5,000 to 9,000 cubic feet of air per hour.

If a room has an open fireplace in which a fire burns, there is sufficient change of air; but in a steam-heated or furnace-heated apartment there is too often inadequate ventilation and consequent accumulation of noxious products. Good ventilation is more difficult in some countries than in others; in tropical and subtropical countries houses are built with large windows, doors, halls, and rooms, and there is free admission of air; but in more rigorous climates such conditions are, of course, impossible.

Warm air may be admitted anywhere, cold air only in the upper portion of a room.

The unobstructed passage of air through open doors and windows (perflation) is the simplest method of ventilation, and may be applied daily in any climate for a longer or shorter time, in accordance with the character of the weather. The celebrated Dr. Erasmus Darwin advised the workingmen of Nottingham to preserve their health by opening the windows of their sleeping-rooms whenever they left them to go to their workshops, and to keep the windows of their workshops open whenever the weather was not insupportably cold. Every room should be ventilated, if possible, with opposite windows opened, in order that air currents may pass directly through the apartment; but if the rigour of the climate renders it impossible to keep the windows open for any length of time, or if the cubic space propor-

Perflation.

tionate to the number of occupants of the room is inadequate to afford each individual a proper supply of fresh air, then it will be necessary to have recourse to some special contrivance to maintain a constant renewal of air.

There are a number of inventions of ventilating apparatus that may be conveniently arranged in four classes, as formulated by Dr. Edward F. Willoughby: 1. Direct communications with the outer air by means of inlets through the walls, and outlets in the same position or communicating with the chimney, or by a large funnel in the roof of the house.

Ventilating Apparatus.

2. Ventilation by tubes for the admission of air, with or without similar tubes for outlets.

3. Appliances which utilize the heat and products of combustion of gaslights for purposes of ventilation.

4. Methods in which the heat of the stove is made available for warming the air entering by channels behind the fire, thus combining the heating and ventilating arrangements.

In the first class may be included Dr. Hinckes Bird's simple arrangement of a piece of wood made to fit between the lower sash and the frame; the bottom of the sash rests upon this, and the top is raised above the bottom of the upper sash, affording a space through which the air enters in an upward direction without perceptible draught. Or the lower piece of the upper sash may have holes bored in it to allow air to enter without draught; the objection to this form of ventilation is that it weakens the sash. Or a louvre may be arranged by removing one of the lowest panes in the upper sash and introducing a glass louvre by means of a metal framework. The window may swing, or above the sash there may be a transom attached at the bottom and swinging inward at the top, so as to direct the air against the ceiling. A register may be placed near the ceiling and connected with a flue that passes to a chimney topped by a cowl. A perforated glass or metal disk attached to an upper pane similarly perforated is a convenient ventilator. In cold climates, where double windows are used, excellent room ventilation may be secured by opening the outside sash at the bottom and the inside sash at the top.

In the second class are included bricks having rectangular or conical openings that are placed behind the washboard; or Tobin's tubes, which are right-angled hollow tubes, the horizontal limb of which is exposed to the outer air, and the vertical limb is in the room; this latter system may be associated with one in which a similar set of tubes passes from the ceiling to an exhaust shaft to remove the foul air.

The third class is exemplified by MacKinnel's tubes, which consist of one cylinder inside the other, the area of the inner tube and of the space between the inner and outer being equal, both passing from the ceiling

to the outer air; the inner tube projects above and below the outer; and if a gas jet is placed below the inner opening the hot and vitiated air passes out through the inner tube, while fresh cold air is introduced through the outer tube. This apparatus can not well be used in conjunction with any other ventilation method.

The fourth class includes such methods as the hot-air furnace, in which the fresh air is made the means of distributing the heat.

Artificial Ventilation.

Fresh air may be introduced and foul air withdrawn from an apartment by mechanical means, the most familiar of which are fans or turbine wheels rotated by steam, water, or hot air.

In order to determine whether the ventilation is adequate it is necessary to know the cubic space of an apartment. In common lodging houses 400 (in New York city), in a schoolroom 300, in military barracks 600, and in a hospital ward 1,200 cubic feet should be the minimum allowance for each occupant. If the room is rectangular the space is easily calculated by multiplying together the length, breadth, and height; from this product deductions must be made for the cubic space occupied by the different articles of furniture, and about three feet for each occupant. If the room has recesses, their cubic capacity must be calculated and added to that of the room; if the recess is triangular, find the area of the triangle by multiplying its base by half its height and this product by the depth of the recess; if conical, multiply the area of the base by one third the height; if cylindrical, multiply the area of the base by the height.

HEATING.

Various Methods.

When the temperature of the air is so low that the rapidity of radiation of heat from the body is greater than its production, it is necessary to produce warmth artificially. The loss of body heat may be limited by heavier clothing, but this will only prove a substitute when the individual is exercising. Heat may be disseminated by radiation, in which it travels through the air without warming it; by conduction, in which the heat passes from one molecule of matter to an adjacent one; and by convection, in which the heat is carried by masses of warmed air. Heating may be accomplished by fireplaces, stoves, furnaces or heaters, hot-water pipes, and steam pipes.

The Fireplace.

A fireplace is a familiar means of supplying radiant heat; but as the intensity of the heat is inversely proportional to the square of the distance of the person to be heated, while those immediately around the fireplace are warm, those in a distant part of the room may be less comfortable. It is an extravagant method of heating, consuming about eight pounds of coal per hour, five eighths of the heat from which passes out of the chimney; it also involves

considerable labour in carrying coal and removing ashes, and the latter increase the amount of dust in the room. The fireplace should stand as well forward in a room as possible, so as to secure the radiation from its sides; and it should be built in an inner and not, as is usually the case, in an outer wall of the house, in order that the heated chimney may benefit the temperature of the dwelling rather than dissipate its warmth in the external air.

In a good open fireplace the back width of the grate is one third of the front width. Having the sides at this angle increases the radiation of heat into the room. The back of the grate should curve forward. The chimney flue should be narrow, and there should be but little space between the floor of the grate and the ash pan, so that the combustion of fuel will be slow.

Gas as Fuel.

Where natural gas is plentiful and cheap, open fires of gas, or gas logs, in which the gas from Bunsen burners heats imitation logs made of iron and covered with asbestos, is a clean and easily managed method of heating; and if the products of combustion are carried up a flue it is hygienic. But this commendation does not extend to gas stoves that are unconnected with a flue; these quickly use up the oxygen in a room, and produce a quantity of carbonic acid that is likely to prove disastrous to those breathing such a vitiated atmosphere.

Stoves.

Stoves may be of iron, fire clay, or porcelain. They entail considerable labour, are more likely to smoke and get out of repair than open grates, render the air too dry and burn the organic matter in it, producing disagreeable odours, and, when made of iron and overheated, allow the escape of carbon monoxide and dioxide into the apartment. There are many varieties of stoves, but almost all, if not all, have the disadvantage of allowing the escape of gases in the course of time, in consequence of too rapid combustion of fuel with too great closure of the flue aperture.

Furnaces.

Furnaces or heaters are in general use in American cities. They consist of a large fire box surrounded by a hot-air chamber containing a water reservoir, and connected by an ingress box, flue, or shaft, with the external air. The heated air ascends through flues and enters the rooms by registers placed some distance above the floor. The use of furnaces is advantageous in that it does away with the necessity of having but one fire for the house, the coal and ashes are confined to the cellar, and the heat can be increased as may be desirable. But in this last respect lies also the great disadvantage of furnaces, for too often the furnace is too small for the house, and in very cold weather it is so heated that the expansion separates the joints of the several pieces of the fire box, and the noxious coal gases escape into the

hot-air chamber and are carried throughout the dwelling. Another disadvantage is that the water reservoir in the hot-air chamber is too often allowed to remain empty, and consequently there is no moisture in the heated air entering the living-rooms. A most serious disadvantage is that the air may be obtained in part from a cellar containing a servants' water-closet that is badly flushed or not flushed at all, slop buckets, or decaying vegetables. The air shaft is often loosely constructed of boards unprovided with movable sides or bottoms, to permit cleaning at the commencement of each cold season, or with a gauze or cheese-cloth filter to retain the particles of organic and inorganic dust which are derived from the outer air.

Steam Coils and Steam Pipes.

Steam coils or steam pipes are largely used in the United States for heating purposes. The frequency with which elevators and dynamos are used in public buildings, stores, and manufactories renders steam serviceable for each of them. The creation of steam-supply companies in large cities furthers the employment of steam for heating. Steam heating may be direct by means of radiators placed in a room, or indirect by means of a radiator placed in a box communicating with an air shaft, the hot air entering the room by means of a register. Steam heating is an excellent method, because by means of an electric thermostat the temperature can be regulated mechanically, the necessary amount of moisture may be obtained by means of vessels containing water placed upon the steam coils, and there is no consumption of oxygen or production of noxious gases. The objection to it is its first expense.

Hot-water Heating.

There are two kinds of hot-water heating—one in which the water is heated in a boiler before it circulates through the pipes, the other in which the pipes are directly heated in the furnace fire; the former is called the low-pressure, the latter the high-pressure system.

There is a direct relation between the pressure and the temperature in the high-pressure system, in which wrought-iron pipes having one-half-inch diameter are used, a short piece of empty pipe being placed at the highest point of the system to regulate the expansion of the water, which is heated to 300° Fahr., but which rapidly cools with any decrease in the fire; there may be differences in the temperature of different parts of the same coil.

In the low-pressure system the water is heated in a boiler and rises by its specific gravity into the pipes and coils, forcing before it the water which has cooled. The water in the pipes may attain a temperature of 200° Fahr. Mr. Anderson calculated the emission of heat by hot-water pipes, and concluded that for ordinary dwelling-houses one square foot of pipe surface was necessary for every sixty-five cubic feet of space.

LIGHTING.

Value of Daylight.

The illuminating power of daylight in an apartment is almost directly proportionate to the square of the distance of the object from the window. Interference with the admission of daylight by trees, vines, flowers, or draperies is inadvisable. Bacteriological investigations have proved that the micro-organisms of disease flourish best in the dark or in subdued light. Physiological research has proved that daylight exercises an important influence on the health of human beings. So God's mandate, "Let there be light," should be reverently obeyed by all householders.

The window areas of all rooms, especially sitting and sleeping rooms, should be generous. The glass should be kept well cleaned, and the draperies only sufficient to prevent glare. In schoolrooms the windows should extend from a few feet above the floor almost to the ceiling; the desks, which should slope at an angle of from thirty-five to forty-five degrees, should be placed so that the light strikes them *from behind and from one side.* Artificial illumination is obtained by means of gas, petroleum, or other oils, electricity, and candles.

Gas.

Reference has already been made to the disadvantages of gas as fuel in consuming oxygen and producing undesirable combustion products—disadvantages that are outweighed by its convenience and cheapness for illuminating purposes and the lessened risk of fire. The constituent of coal gas which affords illumination is carburetted hydrogen. The burners in common use are the fish-tail, in which there is a slight concavity in the top and two apertures convergent from below upward, so as to cause the two gas streams to meet; the bat's wing, in which there is a vertical slit in a hemispherical top; and the Argand, in which there are numerous apertures in a circular ring. In all of these there is imperfect combustion of gas, but an incandescent gas burner has been invented in which a Bunsen burner is surrounded by a cylinder of asbestos gauze treated with zirconium sulphate. This cylinder in the presence of the heat of the burner becomes incandescent and produces a brilliant white light.

The Student Lamp.

For reading purposes there is no light superior to that of a German student lamp, in which the flame from a kerosene or petroleum burner is used. An opaque glass shade, green externally and white internally, should be used, to prevent dissipation of the light rays. The inspection of coal oil in all States, and improved processes of manufacture, have resulted in the production of an oil that is less easily inflammable than that used some years ago.

Candles and colza oil are so expensive in comparison with their scanty illuminating power that they are not likely to be generally used.

The electric light may be produced by the incandescence of a loop of carbon filament inclosed in a glass globe exhausted of air, or by the incandescence in the approximated tips of two carbon rods exposed to the air; the first is called the incandescent and the latter the arc light. The advantages of electric light are that it is as easily managed as gas, it does not pollute the atmosphere, it may be introduced into a dwelling without danger from the strength of the current, and its illuminating power is greater than that of gas; the obstacle to its use is its cost. The latter objection is now less serious than it was a few years ago; and with improved methods of producing electricity seems likely to disappear before very long.

The Electric Light.

CHAPTER IV.

METEOROLOGY.

Meteorology is the science which treats of the atmosphere and its conditions, particularly in reference to heat and moisture. In the scope of this article it is impossible to enter into any consideration of the laws governing the various phenomena of thermometric and barometric variations, winds, humidity, and rainfall, all of which are intimately associated.

Definition.

The temperature is due not only to the passage of the sun's rays through the atmosphere, but also to conduction from the rays in impact with the earth's surface.

For the determination of temperature thermometers are employed. These instruments may be graduated fine glass tubes having an expanded bulb containing mercury or alcohol; or they may consist of thin spiral strips of brass and steel arranged with the former as an inner and the latter as an outer coil, the centre of the coil being fixed and the free end communicating with an index that moves along a scale that has been accurately graduated by means of a mercury thermometer; the brass expands at a high temperature more strongly than steel, and at a low temperature the latter contracts the coil.

Determination of Temperature.

The mercurial thermometer, graduated according to Fahrenheit's method, is most commonly employed in the United States and Great Britain. This scale was invented in 1714; the zero was obtained by placing the thermometer for about one quarter of an hour in a mixture of equal weights of snow and sal ammoniac, because it was the lowest temperature then known

The Mercurial Thermometer.

and was supposed to represent absolute cold; the point was recorded on the glass. The bulb of the thermometer was plunged amid pieces of ice about the size of peas and then placed under the arm of a healthy man, and that temperature was recorded as blood heat; the space between this and the zero was at first divided into twenty-four degrees, which made the point at which water freezes eight degrees above zero. Subsequently each of these long degrees was divided into four short degrees; that made the freezing point of water thirty-two degrees and the normal temperature ninety-six degrees. The boiling point is obtained by placing almost the entire length of the thermometer in a current of steam produced by boiling water in a flask or other inclosed vessel. In from ten to fifteen minutes after boiling has commenced the thermometer will register the maximum point, which is also marked on the glass, correction being made for barometric pressure.

Fahrenheit, Celsius, and Réaumur.

By Fahrenheit's scale the space between the freezing (32°) and the boiling (212°) points of water is divided into one hundred and eighty degrees. In the Celsius, or centigrade, and the Réaumur thermometers the zero point is obtained by plunging the bulb into small pieces of ice and the boiling point by immersion in steam, as above described; but Celsius divided the intervening space into one hundred and Réaumur into eighty degrees. Consequently 212° Fahr. equal 100° Celsius or 80° Réaumur. To convert Fahrenheit into centigrade temperature is effected by the following formula (C = Centigrade, R = Réaumur, and F = Fahrenheit):

$$C^\circ = \frac{(F^\circ - 32) \times 5}{9}; \text{ or the reverse, } F^\circ = \frac{C^\circ \times 9}{5} + 32.$$

$$R^\circ = \frac{(F^\circ - 32) \times 4}{9}; \text{ or the reverse, } F^\circ = \frac{R^\circ \times 9}{4} + 32.$$

$$R^\circ = \frac{C^\circ \times 4}{5}; \text{ or the reverse, } C^\circ = \frac{R^\circ \times 5}{4}.$$

The Mean Temperature.

Thermometers are placed in the shade in order to determine the temperature of the air and exclude the action of the sun's radiant heat upon the thermometer; and in order to obtain accurate temperature of rooms it is necessary to exclude the radiation from heaters, grate fires, stoves, gas, lamps, etc., by means of screens; if an accurate record is essential the temperature of the room must be taken at the floor, the ceiling, and the middle of the apartment, at an outer and an inner wall, in the centre of the room, and near the heating apparatus; add together the various temperatures obtained and divide the sum by the number of observations made, and the quotient will be the mean temperature.

Maximum and minimum thermometers are used for accurate record of temperature. Usually that of Rutherford is employed, in which the

instruments are attached horizontally to a glass plate or board, the bulb of one pointing to the left and that of the other to the right. One is a mercury thermometer with the bulb directed downward, in which the column propels a minute steel rod to the maximum or farthest point it reaches, and the other is an alcohol thermometer having its bulb directed horizontally; against the column of the fluid rests a small porcelain rod, past which the alcohol flows when the temperature rises, but as the temperature falls the rod is carried back to the lowest point by the surface cohesion of the fluid. The mean temperature is obtained by adding the maximum and the minimum and dividing the sum by two.

Metallic thermometers are made as recording thermometers or thermographs. A fine point holding a few drops of ink is attached to the extremity of the index, and a chart moved by clockwork passes continuously beneath the index. The curve of the temperature is thus recorded during a day, a week, or a month.

At meteorological stations an ordinary and a maximum and minimum thermometer, a psychrometer, a hair hygrometer, and a barometer are employed in making observations. The psychrometer, used to ascertain the amount of moisture in the air, consists of two ordinary mercurial thermometers, the bulb of one instrument being covered with a piece of muslin that is kept covered with water; this is called the wet bulb; the evaporation of the water cools the bulb, and the bulb is cooled more and the evaporation is greater the dryer the air is. From the difference between the dry and the wet bulbs the relative humidity is calculated.

Determination of Humidity.

A hair hygrometer consists of a hair, about twelve inches long, freed from oil by soaking in ether for twenty-four hours; it is mounted in a brass frame, its lower end wound once around a pulley and stretched by a weight of about 15·4 grains troy. At ordinary temperatures the hair changes about one thirtieth part of its length, according to the moistness or dryness of the atmosphere, and by means of this change in the length moves an index over a graduated arc that indicates the relative humidity.

Determination of Atmospheric Pressure.

Torricelli found that if a tube about thirty-six inches long and a quarter of an inch in diameter were closed at one end, filled with mercury, and placed open and downward in a cup or vessel containing mercury, there always remained in the tube a column of mercury about thirty inches long. This column is maintained in place by the pressure of the air—that is, on an average, about 14·67 pounds to the square inch. The amount of pressure varies continually within small limits. A barometer constructed in the foregoing manner is called a cistern barometer, the variations in atmospheric pressure being determined by means of a scale. This instrument is usually inaccurate, one cause being the capillary de-

pression of the mercury in the glass tube. The defect may be corrected by using a wider tube, or employing a tube that has a slightly increased diameter as its closed end is reached. In the siphon barometer the tube is shaped like the letter J, and the mercury column in the long tube is counterbalanced by the atmospheric pressure plus the weight of the column in the short tube; the atmospheric pressure is measured by the difference of the lengths of both columns, a scale being attached to the instrument or the glass being graduated.

Another variety of barometer is the aneroid, an instrument of which the essential principle is that an elastic metal case exhausted of air is compressed in proportion to the amount of atmospheric pressure. The case may be an almost circular metal tube that has been exhausted of air, and is fastened to a box by its middle portion, its extremities being attached by rods to an arc of a toothed wheel that moves an index. As the pressure rises, the ends of the tube approach each other. Or, instead of a ring, a strong metal box, one side of which is of thin metal that is made concave by air pressure, may be exhausted of air. A rod, soldered to the centre of this thin metal side which forms the lid, supports a horizontal arm holding a small metal block. A spring holds a second small block, and the relative position of these blocks is changed by an increase of pressure which forces in the lid, or a decrease of pressure that allows it to rise, and by means of a screw this change is recorded. The scales of both these instruments are graduated by a mercurial barometer.

In order to read the record of a barometer, the position of the summit of the meniscus of the mercury column is determined, usually by means of a rod or vernier that may be moved by a screw or by the hand; the inches and tenths of inches are read directly on the scale, and the hundredths and thousandths on the vernier.

The instrument should be placed in a room that has a uniform temperature, and near a window in such a manner that it is lighted without exposure to the direct rays of the sun or to air currents. It must hang perpendicularly in such a fashion that the top of the column will be at about the level of the eyes of the observer. Some instruments are made so that they establish their own equilibrium; all that is necessary is to hang them on a hook.

All barometer readings must be corrected for instrumental error, for capillarity, for temperature, and for altitude above the sea level. In the monograph, *Instructions for Voluntary Observers*, published by the Chief of the United States Weather Bureau, full instructions for the use of these instruments are given.

The direction, the strength, and the duration of aërial currents are of interest from a hygienic standpoint. The first is determined by weathercocks; the second by an instrument called an anemometer, which

consists of four hollow hemispheres attached to the extremities of four rods fastened, at right angles to each other, to an axis connected with a series of cog-wheels. The rotation of the earth and consequent exposure of its surface to the sun's heat, the saturation of air with evaporated water, the radiation from the earth's surface, and the influence of elevations, are factors that are concerned in the causation of winds.

Movement of the Air.

Climate is the combined effect of temperature, density, humidity, rainfall, winds, and some other factors which are modified by soil, elevation, proximity to the equator or to seas, lakes, or mountains, and other local features of the environment. For example, forests diminish terrestrial radiation, increase rainfall, and moderate the heat of hot climates and the cold of cold regions.

Climate.

Climate is divided into warm, extending from the equator to 35° latitude; temperate, extending from 35° to 55° latitude; and cold, extending from 55° to the poles; these are subdivided into equatorial, tropical, subtropical, subpolar, and polar.

The adaptability of the human organism to climate is evidenced by the population of various regions of the earth. In climates in which the temperature of the air equals or exceeds that of the body less food is required, because there is less demand for the production of body heat; the skin acts more vigorously, and there may be a deposit of pigment in its deeper layers; and there is indisposition to physical or mental effort. In very cold climates clothing and carbonaceous food enable the individual to resist the rigour of the regions, and there is an increase in mental and physical vigour; in such climates more carbonic acid is given off; there is more waste of tissue in order to maintain the animal heat; growth does not increase, although it is maintained at a normal standard, and muscular power is increased. In a temperate climate man attains the best physical and mental development.

The degree of absolute humidity is an important factor; the drier or colder the atmosphere the greater the excretion of water by the lungs. Furthermore, in a dry, hot air perspiration is imperceptible, because it is at once taken up by the air. A marked increase in humidity in a warm temperature diminishes the excretion of moisture by the lungs and the skin and increases its excretion through the kidneys and intestines, and renal irritability or diarrhœal diseases may follow.

Ocean climate, while varying in different latitudes, is distinguished by its equability. The evaporation of the water decreases the sun's heat by day and impedes the radiation of heat from the earth at night, and thus modifies the difference between the day and night temperature; and the air contains a greater percentage of ozone, as well as small proportions of iodine and bromine vapours. The barometric pressure and great humidity

diminish the pulse and respiration rates, there is an increase in tissue change, with consequent improvement in appetite and sleep. The seashore is therefore of benefit in convalescence from disease, in conditions in which there is bad nutrition, especially in children, in scrofulous diseases, in some forms of disease of the heart and arteries, in neurasthenia and states of nervous irritability, and in some forms of kidney disease.

Island climates are necessarily influenced by the size and configuration of the island, its latitude, and the character of the ocean surrounding it. In summer much benefit may be derived from the bracing climates of the islands on the coast of Maine, while in winter the benefit of a residence in some of the Bahamas, Bermudas, or other of the West Indies is decided for those having weak lungs or suffering with nervous prostration.

An inland climate may be moist and warm or moist and cool, dry and warm or dry and cool. Moist and warm climates are found where there is little elevation above the sea level, much vegetation, and moisture from sluggish streams; they are unsuitable as hygienic residences, as malarial fevers usually abound. Similarly, moist and cool climates are hygienically undesirable because they produce rheumatic and catarrhal affections. Dry and warm climates are hygienically suitable and are especially advantageous for invalids; in winter in the United States, southwestern Texas, southern California, Arizona, New Mexico, and southern Utah, and abroad Egypt and Nubia, have climates of such a type. Dry and cold climates are of therapeutic advantage in winter, as has been proved by the experience of invalids in the Adirondack Mountains and in eastern Colorado. The advantages of these latter localities are partly due to the elevation; both the absolute and relative humidity are low, the air is aseptic in consequence of the absence of inorganic and organic impurities, the atmosphere is not vitiated by gases from manufactories, and the sunshine is hotter and the air cooler.

A mountain climate is useful in anæmia and chlorosis, in malarial poisoning, in loss of appetite and gastric disturbances, in chronic catarrh of the throat and bronchial tubes, in weak lungs, and in nervous conditions.

In diseases of a chronic character, in convalescence from disease, and in conditions in which there is a predisposition to disease, a change of climate is often of the greatest importance. The sudden changes of temperature during the winter in the Northern States are very trying for people advanced in years, and it would be prudent for them to have a winter residence in southern Alabama, western Texas, New Mexico, Arizona, or southern California, where they could go on the approach of winter and whence they could return when spring was well established.

CHAPTER V.

THE SOIL.

The problems regarding the soil in its relation to public health are very complex. From a hygienic standpoint it is desirable to know whether it is adapted for habitation, irrigation fields or cemeteries. The surface soil may be principally composed of gravel, clay, or sand, but the subsoil is often of a different nature, as one may ascertain by sinking a well or a shaft, a succession of different materials being encountered. The surface soil consists of altered and decomposed rock and humus, and in the interstices between the particles there are air (ground air) and water (ground water). The long-continued action of the sun, frost, rain, and minute vegetable growths break up the rock into brash, which is further disintegrated into mud, clay, or sand, and is mixed with the products of decomposition of animal and vegetable matter. The rock lichens, which grow upon the decomposing surface of the rock, absorb moisture and carbonic acid from the atmosphere and disintegrate the surface of the rock; the lichens die and are further broken up by the bacteria of decay, and upon this mixture of disintegrated rock, organic matter, and bacteria other lichens grow and die; in course of time they are succeeded by mosses, and the rock is more and more broken up and the layer of organic matter constantly increased, until finally it is possible for more highly organized plants to grow.

Composition.

The acid rocks, in decomposing, yield clay, silica, and the alkaline carbonates. Granite decomposes into a loam and the schists into a loamy soil. The basic rocks decompose into a marl or coloured clay and the carbonates of calcium, magnesium, and iron.

Prof. Darwin showed the important influence earthworms exercise in forming the soil. He said: "When we behold a turf-covered expanse we should remember that its smoothness, on which so much of its beauty depends, is mainly due to all the inequalities having been slowly levelled by worms. It is a marvellous reflection that the whole of the superficial mould over any such expanse has passed and will again pass every few years through the bodies of worms."

Function of Earthworms.

In the first portion of this article reference was made to the fact that without micro-organisms it was impossible for fermentation, decomposition, putrefaction, and like processes to take place. Miquel estimated that something less than sixteen grains of soil from the Rue de Rennes in Paris contained about 1,300,000 germs; Eberbach found in Dorpat soils 500,000 germs; Beumer found in the soil at Griefswald 1,250,000 germs if it was examined at once, but if the

Micro-organisms.

examination was delayed he obtained 45,000,000 germs; while Maggiora, at Turin, calculated that he found 78,000,000 germs in about one fourth of an ounce of soil. Fraenkel found that in the upper layers of cultivated as well as uncultivated soils there were from 100,000 to 350,000 micro-organisms in something more than fifteen grains of soil; but if the latter was obtained below the surface of the ground, at depths varying from three to six and a half feet, the proportion of microbes decreased markedly and proportionately to the depth, varying from 2,000 to 200 germs at the lower depth, while between nine and twelve feet below the surface few if any organisms were found.

The vast majority of the micro-organisms found in the soil do not produce disease; some of them favour and some retard the disease-producing organisms. Of the latter, there are found in the soil the bacilli of tetanus, of malignant œdema, of splenic fever, and the coccus which causes pus formation.

Subsoil Water.

The rain water that falls upon the earth either wholly or partly sinks beneath or wholly or partly runs off the surface, in accordance with the character of the upper layer of the earth, whether sand or clay, flat or hilly. The subsoil water is that which sinks beneath the surface until it reaches an impermeable stratum, along the surface of which it percolates until it finds an outlet, usually in a spring, or sinks deeper into the earth, permeating the deepest layers of rock and constituting the ground water. The upper level of the subsoil water varies with the nature of the superficial and deep layers of the soil, their inclination, and the quantity of rainfall; and it is in constant movement, usually toward the nearest water course. Pettenkofer found that it moved toward the Isar at Munich at the rate of fifteen feet daily, and that there was a difference of ten feet between its highest and lowest levels during the year.

Pettenkofer held that the greatest number of deaths from typhoid fever occurred when the ground water was at its lowest level; and while there was a coincidence in these facts at Munich, the relationship has not always existed in other localities. In the United States and England it is generally held that typhoid fever is a water-borne disease, which is often produced by ground water carrying the germs from a privy or cesspool to a well. But the able investigations of Dr. Henry B. Baker, Secretary of the State Board of Health of Michigan, showed that for several years there was a direct relation between the sickness and deaths from typhoid fever and the depth of water in wells in that State; in the month of October, when the water in the wells reached its lowest level, there were the most deaths and sickness from typhoid fever, and in the month of April, when the level of the well water was highest, there were the least deaths and sickness therefrom.

The investigations of Prof. Bowditch in Massachusetts and of Dr. Buchanan in England proved that there was a direct relation between the dampness of the soil and the prevalence of tuberculosis. This is the result of the bad influence such soils exert on the residents thereon rather than upon any multiplication of the bacillus tuberculosis in the subsoil water. The introduction of subsoil drainage has greatly reduced the mortality from phthisis in a number of localities.

Dr. Ballard found that in England there was a curious relationship between infantile diarrhœa and the temperature of the soil; this variety of children's disease always increases in the summer months, and he found that when a thermometer placed four feet beneath the earth's surface reached a temperature of 56° Fahr. there was increased mortality from infantile diarrhœa, no matter what the temperature of the air might be. This is simply a coincidence, aside from the depressing effects of hot weather on the infants, because infantile diarrhœa is a fermentation process that follows the introduction of certain micro-organisms into an infant's gastro-intestinal tract by means of its food.

So malaria, diphtheria, rheumatism, and pneumonia have been ascribed to subsoil water, though the only part subsoil water could have in developing those diseases would be its bad influence on the general condition of persons living in a territory where that water remains at a high level.

Ground Air.

There is a certain amount of air in all soils, the quantity depending upon the loose or compact character of the soil; in fact, only the hardest rocks are free from ground air. Pettenkofer found that ground air contains more carbon dioxide than is in the atmosphere, the amount of the gas increasing with the depth from which the air is obtained, being greater in autumn than in spring, and increasing with the temperature and the moisture of the soil; these results were corroborated by Fodor at Budapest and Flech at Dresden, who found that the oxygen of the air on passing into the soil enters into a chemical combination with carbon derived from various animal and vegetable sources. The amount of nitrogen in the ground air is almost constant; ammonia, ammonium sulphide, hydrogen sulphide, and marsh gas are also found in variable quantities in ground air, according to the degree of decomposition and putrefaction going on. No soil absorbs gases in exactly the same proportion in which they exist in the atmosphere; some absorb more oxygen, some more nitrogen.

The ground air, like the ground water, is in constant motion, the wind in its passage over the soil withdrawing air from it; a low barometric pressure increases the amount of carbonic acid in the upper layers of the soil; changes of temperature influence the diffusion of the ground air; in autumn and winter, when the soil is warmer than the atmosphere, the

ground air escapes and is replaced by the colder atmospheric air, while in spring and summer it is colder and denser than the atmosphere, and subsides into the lower layers of the soil. Rain will force the ground air to a deeper level, although it is likely to escape at some distant locality where the soil was not wet; and elevation of the level of the ground water necessarily elevates the superjacent level of the ground air.

From a sanitary standpoint the ground air is important because in buildings in which there is a heating apparatus in the cellar the increased warmth of that apartment serves to aspirate the ground air from the colder earth beneath the cellar floor and about the walls of a house. Pettenkofer found that escaped coal gas found its way through twenty feet of soil and affected the inmates of a dwelling. When the gaseous odour of the upturned earth of a city street is recalled, it will be understood how easily the gas in such earth can pass into a cellar and how insidiously it will affect the health of householders. The necessity of laying gas mains in cemented, ventilated trenches so as to avoid infecting the ground air with the constant leakage from the mains is apparent.

Building Sites.

In selecting a site for a house an elevation should be chosen, such as the ridge of a hill or a gentle slope, rather than a valley or a steep declivity. The greater exposure of the elevation to the sun and the wind results in the soil being drier, the air more thoroughly exchanged, and the noxious gases more rapidly and completely removed. The washing from heights always brings a quantity of decomposable organic matter into a valley, and there is a higher level of ground water. The question of exposure is largely a matter of latitude; in some localities an easterly or southerly, in others a westerly or northerly frontage is preferable, according to the desirability of avoiding winds or of securing or avoiding sunshine. Localities in which the soil is moist in consequence of bad natural drainage, too great height of the ground water, or overflow of a river, should be avoided. Solid rock, sandy or pebbly soils, in which there is a minimum amount of organic matter, are the best grounds for building.

For an irrigation field a large territory of permeable sandy soil is most suitable on account of its capacity for moisture; gravel soils do not retain enough water, and clay soils are impermeable. In selecting land for a cemetery in which the dead may be disposed of by inhumation the soil should be of such a character that the bodies will rapidly decay. The ground water should not at its highest level approach within from eight to nine feet of the surface, so gentle slopes or elevated plateaus are the best sites; if there is a high level of ground water it may become infected with pathogenic microbes from dead bodies and carry these disease-producing germs to a source of water supply.

Made soils—that is, ground formed by filling in low-lying or marshy

ground, water courses, gullies, and excavations with ashes, garbage, and other refuse—should be avoided, for such foundations are not only damp, but are easily penetrated by ground air.

CHAPTER VI.

WATER.

WATER is a compound of oxygen and hydrogen in the proportions of eight parts by weight of oxygen to one of hydrogen. At a temperature of less than 32° Fahr. it forms a solid ice, and above 212° Fahr., at a barometric pressure of thirty inches, it becomes a gas (steam); during the process of freezing water expands 8·5 per cent. in volume and gives off a large amount of heat, which is again absorbed when the ice is liquefied. So, when boiled, water expands. Reference has been made to the disintegrating effect the solidification of water has upon rocks and soils; and the influence of the expansion of the water in breaking supply pipes in a house in a cold climate is a familiar experience to most persons.

Composition and Characteristics.

Water is an almost universal solvent, taking up a greater or less quantity of all the gases and of most of the metals and their salts. The rain in falling becomes charged with the gaseous and solid constituents of the atmosphere, and water in flowing over or through the soil dissolves various organic, inorganic, and gaseous substances contained therein.

The atmosphere is an immense sponge into which watery vapour is absorbed by means of the heating influences of the sun's rays, and from which it is in course of time precipitated as rain, hail, or snow.

While water is one of the greatest necessities of man, with air and food constituting the tripod upon which life rests, it is, in consequence of man's carelessness, one of his most active enemies, because several of the communicable diseases which are most prevalent and which largely increase the mortality rates are water-borne diseases. In most civilized countries the spectacle is presented of a water supply that is contaminated by the excreta of the inhabitants of the locality or by their neighbours, and there is nothing that gives a community more concern than the question as to where it may obtain a supply of pure water.

Sources of Supply; Rivers.

The sources of water supply are rivers, lakes, wells, or rain; by the term river may be implied all running water, no matter what the size of the stream. The amount of water in a running stream depends upon springs, ground water, and surface water. Rain or snow, which are the products of the evaporation

of water, fall upon the ground and a portion flows off, according to the inclination of the surface, while another portion percolates through the interstices of the soil and forms the ground water, which eventually finds its way to some spring or other running stream. In flat countries, in which the soil is dense or clayey, the surface water may be evaporated largely, although everywhere a portion of the surface water is evaporated while a portion is absorbed by the roots of grasses, trees, and other vegetation. Dr. Gilbert calculated that of an annual rainfall of thirty inches, nineteen or twenty inches are thus evaporated; the amount of evaporation depends upon the amount of vegetation, as on bare earth only seventeen out of thirty inches of rainfall are evaporated, and on sandy soil only four inches out of twenty-five are thus disposed of. The evaporation is greater at a high than at a low temperature.

River water varies in quality and purity, some streams, like the Mississippi and Missouri, containing large amounts of inorganic matter in suspension and solution, others containing both inorganic and organic matters in solution, these qualities varying with the territory through which the streams flow. The water of a river is likely to be further polluted by the sewage of cities and the refuse or water from mines and manufactories, and by the surface drainage from lands fertilized by manure.

The addition of a moderate quantity of sewage to a flowing stream may not exercise any specific deleterious influence on the stream, because there is a certain amount of self-purification in running water in consequence of the action of sunlight, the oxygen of the air, water plants and bacteria, and fish. But the oxidation of sewage is a slow process, and it is not possible to say how far a stream must flow beyond the point of entrance of sewage before the latter is completely oxidized.

In a last analysis all fresh water passes through the phases above referred to from its origin as rain until its re-evaporation. Dr. George Vivian Poore tells us that an inch of rain is equal to 22,624 gallons per acre, and with the remarkable variations in rainfall in the United States of from less than five to over seventy inches per year, it is seen that there are precipitated from 113,120 to 1,583,680 gallons of water per acre.

Wells.

Wells are either surface or shallow, deep, or artesian; surface wells are those which are sunk into the superficial layers of the soil, receiving their supply from the ground water; deep wells penetrate through a stratum impermeable to water, and receive their supply from a deep spring or the deeper water courses; while artesian wells or tube wells pass through a number of strata and reach water some hundreds of feet beneath the earth's surface. The depth of a surface well varies with the distance of the first impermeable stratum from the earth's surface; the water is subsoil water, its height in the

well depending upon the height of the subsoil water, which varies at different seasons of the year, as has been mentioned; this water is rarely pure, because it is often polluted by percolation through manure heaps and leakage from cesspools. If the latter are situated in ground at a lower level than the well there is no chance of such contamination, but if situated in ground on a level with or higher than the well such contamination is unavoidable. A surface well drains water from a region that may be represented by an inverted cone with the bottom of the well as the apex, and the radius of the base of the cone is twice the depth of the well, so that a well fifty feet deep would drain all the surface of the ground for one hundred feet in all directions from its mouth. As, however, the drainage of a surface well will vary with the character of the soil and the season of the year, and may be affected by territory more remote than twice its depth, it is best to locate such a well much farther from a possible source of contamination than that above mentioned.

A draw well, open at the top, is much more exposed to pollution and infection than a pump well, and this is also more true of a well which has brick or cement sides than of one which has iron pipe as its lining. The mouth of the well should be protected by coping and closed over, and the water should be examined chemically and bacteriologically from time to time to determine its potability; such examinations are necessarily the work of an expert. *It must not be imagined because the water of a well is clear, cool, sparkling, and palatable, that therefore it is a good drinking water, for the agreeable taste may depend upon the presence of organic salts associated with carbonic-acid gas.*

As a rule, the water of a deep well, obtained by digging or blasting through an impervious stratum, is better and purer than that of a surface well, though the well may not be as deep as many surface wells. The walls of such a well should be of metal, in order to prevent the gradual filtration of ground water which occurs through a brick wall.

An artesian or tube well is made by attaching a perforated steel nozzle to an iron tube and driving this into the ground, adding new portions of tube and thus boring through several thousand feet of strata. Sometimes pure water is obtained, and sometimes the supply is brackish, or so impregnated with gases and mineral salts that it can not be used for domestic purposes.

Fresh-water lakes when sufficiently large are an excellent source of water supply provided they do not serve as receptacles for sewage, and provided due care is taken by those living in their drainage areas to avoid building cesspools and forming compost heaps that will continually menace the purity of the water. The yearly evaporation from a surface of water in a temperate climate has been estimated at twenty inches (C. Greaves), and this, with the daily consumption of water, demands for the

replenishment of the supply the greatest care of the sanitary condition of the drainage area.

Rain Water.

Reference has been made to the great absorptive power of water, and this quality is manifested in a striking degree by the rain, which in passing through the atmosphere absorbs not only some of the air itself, but also the sulphurous-acid gas, the ammoniacal salts, nitric and nitrous acids, the solid amorphous and crystalline particles, such as soot, dust, etc., and micro-organisms that foul the atmosphere. Rain may therefore be truly said to wash and purify the air; and each gallon of rain collected inland, remote from towns, contains 2·1 grains of saline constituents and 0·07 grain of combined nitrogen in a gallon. The quantity of ammonia and sulphurous acid varies with the locality where the rain falls, but these substances are principally contained in the first rain that falls. "At an ordinary temperature each gallon of rain water dissolves 5·5 cubic inches of atmospheric gases; of this, nearly 2 cubic inches are oxygen, 3·5 cubic inches are nitrogen, and 0·14 cubic inch is carbon dioxide. A part of the oxygen is used by the organic matters in the water" (Dr. Thomas Stevenson). The greatest proportion of bacteria is found in the first rain that falls; Dr. Miquel counted two hundred thousand germs in something more than a quart of rain water. The number of bacteria in the rain in the warm months of the year is greatly in excess of that found in winter and spring rain. Besides bacteria, the spores of fungi, microscopic plants, and the pollen of grasses and flowers are contained in the first portion of the rainfall.

Special precautions should be taken to insure the cleanliness and purity of rain water collected from buildings for drinking purposes; and on account of the impurities it acquires from the air, as well as on account of the presence of dust, vegetable matter, excrement of birds, etc., the first portion of rain that falls should not be preserved.

There are several ingenious devices that have been invented which may be attached to the pipe from the roof to the cistern, and which automatically separate the first from the later portion of a rain. By exercising care in this respect it will be possible to avoid introducing into a cistern organic matter which will decompose and render the water unfit for use.

As good an authority as Dr. Stevenson recommends that if rain water is to be used for drinking purposes it should always be filtered through sand and charcoal, or some similar material, so as to remove suspended matters before storing it. In Louisiana, where large wooden, vatlike cisterns are built on supports above ground, it is customary to interpose a layer of charcoal and sand between the water and the supply pipe. But in other localities the cisterns consist of cement or brick-lined jug-shaped excavations, and the rain water passes into it direct from the roof with-

out preliminary filtration. In some places iron tanks are used for storage and distribution of rain, but the metal quickly corrodes, and has no advantage over the above-ground wooden cistern or the thoroughly cement-lined underground cistern. Under any circumstances the water should be filtered through sand, charcoal, or some other efficient substance before it is stored.

From the reports of the Weather Bureau it is possible to learn the average yearly rainfall in a locality, and with a knowledge of this and of the area of the horizontal surface of roof used to collect the rain it is possible to determine the size of cisterns necessary to store the rain as well as the amount of the supply. The roof area is obtained by multiplying the length by the breadth without reference to the slope of the roof; thus, if the building is 60 feet long by 25 feet broad, the roof area will be $60 \times 25 = 1{,}500$ square feet. In an annual rainfall of 30 inches one fifth must be deducted for evaporation. Reduce the 1,500 square feet to square inches by multiplying by 144, and there are 216,000 square inches, which, multiplied by the total unevaporated rainfall of 24 inches, equals 9,984,000 cubic inches of rain; divide this by 1,728 cubic inches, and there are 56,004 cubic feet, equal to 43,220 gallons, or a daily average of 118 gallons, which is sufficient for a family of three persons. Observation has shown that the rainfall in the driest year is one third less, while in the wettest year it is one third greater than in the average year.

Rain water is particularly useful for washing and cooking on account of its freedom from the salts of lime or magnesia, and is known as a *soft* water. A *hard* water is one which contains these minerals, and the degree of hardness is designated as so many grains of calcium carbonate per gallon; on boiling, the carbonic acid is driven off and the calcium is deposited as a grayish-white substance on the interior of the cooking vessel. Hard water is not desirable for cooking, because some of the mineral substance is deposited on the surfaces of meat or vegetables, and it is undesirable for washing, because the salts combine with the oleic or stearic acid of soap and form a curdy precipitate. One grain of chalk is estimated to waste about eight grains of soap.

The Rivers Pollution Commissioners of England stated that preference should always be given to spring and deep-well water for purely domestic purposes, not only on account of the much greater intrinsic chemical purity and palatability of these waters, but also because their physical qualities render them peculiarly valuable for domestic supply. They are almost invariably clear, colourless, transparent, and brilliant—qualities which add greatly to their acceptability as beverages—while their uniformity of temperature throughout the year renders them cool and refreshing in summer and prevents them from freezing readily in winter. Such waters are of inestimable value to communities, and their

conservation and utilization are worthy of the greatest efforts of those who have the public health under their charge. The commission considered that stored rain water and surface water from cultivated land, while moderately palatable, was suspicious; and that river water to which sewage gained access and shallow well water, while palatable, was dangerous.

In the United States the prevalent custom of disposing of all sewage by emptying it into the nearest water course is gradually polluting the smaller streams and lakes, and is likely in time to seriously interfere with the usefulness of large rivers and lakes as sources of water supply. Such pollution should be stopped by the national Government.

It is necessary for a community to have a liberal supply of water of good quality for drinking, cooking, bathing, washing, scrubbing of all sorts, flushing water-closets and sewers, lifting elevators, and cleaning streets. Dr. Louis C. Parkes estimated that the following quantities were consumed daily for each person:

Need of a Liberal Supply.

		Gallons per head.
Household.	Fluids as drink	0·33
	Cooking	0·75
	Personal ablution	5·00
	Utensil and house washing	3·00
	Washing clothes	3·00
	Water-closets	5·00
Trade and manufacturing		5·00
Municipal.	Cleansing streets Public baths and fountains Flushing and cleansing sewers Extinguishing fires	5·00
Total		27·08

The foregoing estimate does not include water required by animals for drinking and washing, nor the leakage from mains, taps, and closets.

The consumption per head of the population varies in different cities, as may be seen from the following table modified from Mr. A. Wynter Blyth's excellent *Manual of Public Health*:

	Gallons per head.		Gallons per head.
Alexandria, Egypt	18–20	Cairo, Egypt	11
Amsterdam, Holland	11–15	Calcutta, India	2·2
Adelaide, Australia	50	Chicago, Ill.	102·5
Athens, Greece	21–56	Christiania, Norway	39·7
Baltimore, Md.	54	Cologne	53
Barcelona, Spain	7–14	Copenhagen, Denmark	13·9
Berlin, Germany	13·3	Cleveland, O.	45
Bombay, India	20	Cincinnati, O.	45
Boston, Mass	73·3	Detroit, Mich.	87
Buenos Ayres, Argentine Republic	20	Dresden, Saxony	60
Buffalo, N. Y.	60	Frankfort-on-the-Main	59

	Gallons per head.		Gallons per head.
Hamburg, Germany	60	Rome, Italy	160·38
Hanover, Germany	31	Rotterdam, Holland	22·45
London, England	31·25	Rouen, France	30·8
Leipsic, Germany	23	San Francisco, Cal	64·5
Louisville, Ky	24	St. Petersburg, Russia	21·3
Madrid, Spain	3·3	Seville, Spain	7·26
Marseilles, France	158·4	Sheffield, England	35
Montreal, Canada	66	Salem, Mass	55
Munich, Bavaria	33	Stockholm, Sweden	13·5
Naples, Italy	15·4	Stuttgart, Germany	26·4
New York, N. Y.	100	Sydney, New South Wales	25
Ottawa, Canada	102	Toronto, Canada	82
Paris, France	36	Trieste, Austria	4·4
Pesth, Hungary	33	Valparaiso, Chili	20
Philadelphia, Pa	58	Vienna, Austria	13.2–19·8
Rio Janeiro, Brazil	30	Washington, D. C	143

An examination of the table affords no good evidence of the reasons for the consumption. Ottawa, Canada, with a cold climate, consumes six times as much water as Bombay or Naples, with their warmer climates and presumably greater demands for water for bathing and street cleaning. Undoubtedly much water is wasted, especially in larger and newer cities, in which an average of from thirty-five to forty gallons per head per day should be ample. Not only does this unnecessary waste of water entail heavy expenditure to provide a supply, but it also necessitates provision of large and expensive sewers to remove it. The trouble about an insufficient water supply is that there is want of personal cleanliness, habitations are insufficiently cleansed, streets are not sprinkled or washed, and sewers are not properly flushed out. Dr. Pole states that the storage capacity of reservoirs should equal from 150 to 250 days' supply, according to the community and the average quantity of rainfall. Mr. Hawksley has found that a formula for calculating the required number of days' supply which should be stored is to divide 1,000 by the square root of the average annual rainfall in inches. For example, where the average is 25 inches the storage capacity should be $\frac{1000}{\sqrt{25}} = \frac{1000}{5} = 200$ days' storage. Such capacity is, however, rarely if ever attained.

Reservoirs.

In some localities it is necessary to have a system of settling reservoirs, in which a proportion of the suspended matter is deposited before the water is pumped to the distributing reservoirs. All reservoirs should be carefully supervised, in order that they may not be contaminated by thoughtless or malicious persons or by animals; they should be so situated that they are not likely to be polluted by dust from drives or roads; they should be exposed to the air, and if it is possible to arrange for a system of falls for the water when changed

from one reservoir to another, aëration will be improved ; and they should be kept free from water weeds.

An engineer, in calculating the arrangement of the water supply for a town, bases his estimate upon the population, with a reasonable allowance for increase. The supply must be so placed that gravity will force the water above the roof of the highest building. The erection of the unattractive high buildings in a number of American cities has made it impossible to arrange a water supply that can be carried by gravity above their roofs. In such places the water must be pumped to a tank on the roof. In cities in which there is great disparity in the size of the buildings care must be exercised to lessen the pressure of the water in its transit from the large distributing mains to the houses by interposing smaller pipes so as to increase the resistance.

Water Mains and Pipes.

Water mains are either cement-lined brick tunnels or, more frequently, cast-iron pipe, the capacity of the latter being adapted to the greatest demand for water at any hour of the day, and the pipes being coated with pitch, coal tar, or glaze to prevent corrosion.

The mains are usually connected with the house by means of lead pipe. Hard waters soon coat the interior of lead pipe with the sulphate or carbonate of lead, which prevents solution of the lead by the water, while soft waters may dissolve the lead, producing a soluble oxide which is poisonous. Where the water is very soft, block-tin pipes may be used in the house ; or the water may be passed through a filter of sand, broken flint, and pieces of limestone, in order that it may absorb silica, which prevents any action on lead by the soft water.

Systems: Intermittent and Constant.

Most public water supplies in the United States are constant ; that is, water may be obtained at all times from the public mains. In some places, however, the supply is intermittent, the water only flowing for a few hours during the day.

The objections to the intermittent system are that the water must be stored in some receptacle in the house, and whether it be an iron- or a metal-lined tank, or wooden tub, it becomes flat, absorbs impurities from the air, and is likely to be otherwise polluted by organic matter falling into it. The best materials for a cistern are slate, stoneware or tiling, or galvanized iron ; it should be placed in a light and well-ventilated situation, and should be protected by a cover ; the overflow pipe should be properly trapped, and the supply pipe should have an automatic cut-off ; and, finally, it should be regularly inspected and cleaned out if it contains any deposit. With the constant service there is no necessity for house storage of water, the supply is plentiful, and not subject to the deterioration as well as to the multiplication of micro-organisms which occurs in water stored in a tank.

In all systems of public water supply there is a large amount of waste. Dr. Parkes states that in London it was estimated that fifteen out of thirty-five gallons per head ran to waste in the soil in consequence of leaks at the junction of mains and other pipes. Another source of waste is carelessness of individuals about firmly closing faucets, or inattention to a faucet from which there is constant dripping. While a generous supply of water is desirable, unnecessary waste is blameworthy, and it would perhaps be well for each house to have a water metre, as then the occupant of the house would be as careful to prevent water waste as he is to prevent gas or electricity waste when he knows that he must pay for the quantity that is consumed.

Waste of Water.

The pollution of water by solid particles of inorganic matter in suspension or partial solution, and by solid and liquid organic matter, makes its purification a matter of great importance. Reference has been made to the value of settling reservoirs for ridding water of a part of the suspended matter, and it has been ascertained by recent investigations that such reservoirs do more, in that they free the water from a certain proportion of micro-organisms. Tils found in examining the water of the reservoir at Freiburg, Germany, that the number of micro-organisms is invariably smaller in the water from the reservoir than in that taken from the stream supplying the reservoir ; and while he attributed the difference to the limited amount of food material available, it is more probable that, as Frankland says, who cites this case, the decrease is due to the process of sedimentation. Frankland found that water taken from the river Thames, at a point where one of the water companies had an intake pipe, contains more bacteria than either of two small storage reservoirs, and four times as many bacteria as a large storage reservoir in which the water is kept. This observer and his wife found that the water of the Loch of Lintrathen, which furnishes Dundee its water supply, contains more bacteria than the streams that supply the loch, a fact they deemed due to sedimentation.

Purification of Water.

Filtration has been found the best means of eliminating the greater portion of the foreign matter in water. The best media for that purpose are sand and gravel, the sand acting not only as a mechanical strainer, but its fine edges break up and hold organic matter and facilitate its oxygenation. Formerly great stress was placed upon the value of a chemical examination of drinking water, and to-day it is a custom with certain boards of health to publish from time to time chemical analyses of the water supply. In 1883 the then National Board of Health published a report by Prof. J. W. Mollet, who, in association with other distinguished chemists, devoted several years to a chemical examination of

Filtration and Chemical Examination.

potable water with especial reference to the determination of the amount of organic matter contained in it. After several years' labour he concluded that it was impossible to decide absolutely upon the wholesomeness or unwholesomeness of a drinking water by the mere use of any of the processes employed by chemists for the estimation of organic matter or its constituents; and he even expressed the opinion that the results of analyses for organic matter should be deemed of secondary importance in weighing the reasons for accepting or rejecting a water which is not manifestly unfit for drinking on other grounds.

Prof. Mollet referred at that time to the conclusions reached by Müller, Schloesing and Muntz, Storer, Warington, and others as to the process of nitrification being due to the presence of a living ferment, and he suggested that the presence of nitrates and nitrites, which were held to be indicative of the noxious character of water, is really due to the presence of a special nitrifying micro-organism, which is to be classed among the organisms capable of propagating disease. It had been known for years that water contains bacteria, but it was not until 1883 that methods were introduced which rendered the bacteriological examination of water trustworthy. Different investigators have studied the subject, and it has been found that water in its several forms, except boiled, and wherever obtained, contains microbes. Frankland quotes Janowski, who found, in Russia, in fifteen grains of freshly fallen snow, from 34 to 300 living bacteria; and Schmelk found in a similar quantity of snow obtained from a Norwegian glacier, at a point about six thousand feet above the sea level, 2 living bacteria and 2 moulds. C. Fraenkel found in ice from a lake near Berlin from 21 to 8,800 living bacteria in a piece weighing a little more than fifteen grains; and Uffreduzzi found in ice manufactured from water from the river Dora, at Turin, 580 microbes in fifteen grains, a greatly smaller number than was contained in the same quantity of river water, which shows that freezing does kill a number of germs. Foutin found 729 microbes in fifteen grains of hail. Proskauer found in an extended series of observations that in fifteen drops of water from the river Spree, at the intake of the Berlin waterworks, there was a minimum of 750 and a maximum of 17,000 micro-organisms. Miquel found that in fifteen drops of water from the Seine at Choisy, above Paris, there were 300, at Bercy, in the immediate vicinity of the city, 1,200, while at St. Denis, below the city, there were 200,000 bacteria. Percy Frankland found that Thames water, collected above the intakes of the water companies, contained in an average of three years (1886 to 1888) 2,190 bacteria in July and 55,900 bacteria in January, the sun's heat and the increased light serving to decrease the number in the summer months and the washings from the land increased the number in the winter months. Dr. C. Gilman Currier found in the same quantity of

water from the Delaware River, at the waterworks intake, 28,000 bacteria; in water from the Schuylkill River, 43,750 bacteria; in water from a Newark hydrant, 4,000 bacteria; in Mississippi water collected above Minneapolis, 620 bacteria; in Spokane River water, 69 bacteria; in Willamette water, 44 bacteria; and in Saratoga Lake water, 56 bacteria in the surface water and 163 bacteria in that thirty-two feet below the surface and one foot above the bottom.

A chemical analysis of water which had been subjected to sand filtration showed a slight diminution in the amount of solid matter and but few other changes; but bacteriological examination conducted throughout the year showed that there was a decrease of from 95 to 98 per cent. in the number of bacteria. Dr. Frankland states that the factors which influence the number of micro-organisms in the water are: Storage capacity for unfiltered water, so as to have the advantage of sedimentation; the thickness of the fine sand through which filtration is carried on, as the sand loses its filtering power in the course of time, and of course this loss would occur more rapidly in a thin than in a thick layer; filtration if rapid, removes bacteria less perfectly than if the rate is slow; and frequent renewal of the filter bed is essential.

A filter bed is generally constructed as a J-shaped tube in which the longer limb is some ten feet in depth and represents the layers of sand and gravel and the layer of unfiltered water; the pressure of the main volume of water gradually forces the layers just above the sand into and through a two-foot stratum of fine sand, a foot and a half of screened gravel, which is fine at the top and coarse at the bottom, and two feet and a half of broken stone, and the filtered water emerges at the shorter limb. The employment of sand filtration, which has proved of such great value in the experience of a number of European cities, is in slight favour in the United States.

Alum in a proportion of six grains to the gallon of water will precipitate suspended and dissolved matters in a turbid water; the precipitate carries with it a certain amount of micro-organisms, and in the clear water which remains there are fewer bacteria than in the water before the alum was added. Limewater is added to a hard water, so that it will combine with the carbonic acid which holds lime and magnesia salts in solution and forms new compounds, which are precipitated; on a large scale quicklime is slaked in a tank of water, and the water to be softened is allowed to flow gradually into the tank, the water being mixed by mechanical means, such as wheels, paddles, etc.; it becomes milky and is allowed to settle for twelve hours.

For various reasons it may be necessary or desirable for a householder to filter his drinking water. The most recent investigations on the subject of domestic filters showed that the Pasteur-Chamberland filter, in

which water is forced through a cylinder of biscuit porcelain, would filter, at a pressure of about thirty-five feet, about ten gallons of water in twenty-four hours; and that the water, *when the filter was new*, was free from bacteria, but after it had been in use for a short time bacteria appeared in the filtered water. Freudenreich's experiments showed that bacteria multiply and grow in the pores of the filter, and that *every five days* the cylinder should be removed, carefully scrubbed, and sterilized in boiling water. The Berkefeld filter has a cylinder of baked infusorial earth, in the pores of which micro-organisms will grow as in the Pasteur-Chamberland filter; this cylinder should be cleaned by rubbing it with a loofah (a vegetable sponge produced by a variety of gourd) under running water and then placing it in cold water which has been boiled for three quarters of an hour. Esmarch's investigations have shown that filters of porous stone will not interfere with the passage of bacteria, although they may intercept inorganic matter. Asbestos is a good filtering medium, retaining bacteria for a short time, but soon requiring sterilization by heat. Maignen's rapid filter consists of a layer of animal charcoal and asbestos cloth; but this will not intercept bacteria for very many days and is not easily sterilized. Most of the other filters in vogue for domestic use are merely mechanical and temporary strainers, and can not be recommended. *There is no such thing as a perfect filter made*, and in the nature of the multiplication of bacteria it is unlikely that a perfect filter can be made—that is, an apparatus that will deliver water free from germs for an indefinite period. With proper care the first three filters referred to may be relied upon, but the water they furnish is not likely to be much superior to that sterilized by boiling.

Domestic Filters.

Distillation is an excellent method of purifying water, and in a number of cities mineral water and artificial-ice companies supply distilled water. If the first portion of the distillation, in which volatile substances are contained, is allowed to escape, the rest of the distillate is free from foreign ingredients. The distillation of sea water furnishes steamships with their water supply. Small distilling apparatuses have been invented for domestic use, and in marshy countries, or localities in which malaria is prevalent, their use prevents much sickness.

Distillation.

Too often filters are undesirably placed in a dark, damp situation, near sinks, or even closets. They should be in well-lighted places, and the receptacle and the filtered water should be thoroughly sterilized by boiling or baking and allowed to cool with a cover on, so as to prevent the introduction of kitchen air. Not infrequently sterilized water is received in an unsterilized receptacle. While filtration is in process see that the receiver

Care of Filters and Filtered Water.

is properly covered. Do not allow filtered and sterile water to stand exposed to air, and do not keep it indefinitely; use it as it is filtered.

When there is a prevalence of any water-borne disease, such as cholera, typhoid fever, diarrhœa, dysentery, malaria, or yellow fever, sterilize all drinking water by boiling it. The important experiments of Dr. Currier showed that if water be boiled for fifteen minutes all disease-producing bacteria and their spores are killed. The boiled water should be placed in closed vessels and set aside to cool. If cooled while uncovered it will absorb gases and vapours which impart an unpleasant taste. It is also likely to be contaminated by microbes in the air. Boiling drives off volatile gases in the water, precipitates lime salts, and makes the water softer. *Boiled water should not be cooled by adding ice to it.* Reference has been made to the fact that *ice contains living bacteria*, and Prof. T. M. Prudden's experiments showed that the bacillus which produced typhoid fever was alive in ice after almost three and a half months, so it may be appreciated that it would be possible to infect sterilized water by adding ice to it.

Boiled Water.

The methods of water analysis, whether chemical or bacteriological, are too elaborate to be described here, and they should be undertaken only by one who is thoroughly conversant with the subject. In general, it may be said that if an analysis shows that chlorides are present in large amounts in association with ammonia, nitrates and nitrites, and phosphoric acid, the water is probably contaminated by sewage. Ammonia unassociated with nitrates and nitrites or chlorine indicates animal or vegetable contamination, while changes in the relative proportion of nitrates and nitrites suggest the presence of bacteria.

CHAPTER VII.

BATHS AND BATHING.

One of the most important uses of water from a hygienic standpoint is its employment for bathing, and a fit index of the intelligence and culture of a community is the number of bath tubs it contains. As a measure in the treatment of disease, bathing is mentioned in the oldest sacred writings of India, and as a measure of purification it is often referred to in the Old Testament. In the writings of the ancient Greek and Roman physicians bathing is mentioned as a hygienic and a therapeutic measure, and the religious code of the Mohammedans directs that

As a Hygienic and Therapeutic Measure.

it be employed. The necessity of the frequent use of the bath may be recognised when the functions of the skin are remembered; the quantity of perspiration varies with the temperature, humidity, occupation, and quality and quantity of food and drink.

A bath may be local, in which only one portion of the body is immersed, or general, in which there is immersion of the entire body; or the water may be applied as a douche, a shower, a spray, or in fine needle-like streams. There are baths in which water is not used, as in hot-air baths, or the bath may be of vapour impregnated with some medicinal substance. Baths are distinguished according to temperature, as cold, varying from 52° to 60° Fahr.; cool, from 60° to 80° Fahr., according to the season of the year; tepid, from 80° to 90° Fahr.; warm, from 90° to 95° Fahr.; hot, from 95° to 105° Fahr.; and very hot, from 105° to to 120° Fahr.

The Cold Bath.

As water is a better conductor of heat than air, a cold bath abstracts more heat from the body than would a still atmosphere of the same temperature. The contact of the cold water with the skin at once stimulates the nervous system, and the small blood-vessels of the skin are contracted, there is less blood in them, and there is an increased consumption of oxygen and elimination of carbonic acid. But if the bath is continued very long the contraction is succeeded by a paralytic dilatation of the capillary blood-vessels, and the skin has a bluish-red hue. A cold bath of short duration taken on arising in the morning is an admirable tonic, because the contraction of the blood-vessels of the skin increases the amount of blood in the internal organs, especially the central nervous system; there is a more rapid removal of waste products and consequent increase in functional activity. Upon leaving the bath there is a reaction in consequence of the dilatation of the vessels of the skin, there is an increased radiation of heat, and an agreeable sense of exhilaration. Individual susceptibility to cold water varies, and some persons react to a cold bath at a temperature that would cause such a shock to others that the vessels of the skin would be paralyzed by the cold and fail to react and dilate on leaving the bath, and there would be mental and physical exhaustion instead of a sense of capacity for such exertion. For such individuals a cold sponge or shower bath, taken while standing in warm water, will produce the same desirable reaction and sense of well-being as does the cold bath in others.

Warm Baths.

Warm baths dilate the cutaneous vessels, and by this means lessen the amount of blood in the internal organs; they impart health to the body, lessen the excretion of animal heat, and increase perspiration. The hot water is a better solvent of the fatty excretions of the skin than cold water. On account of the dilatation of the blood-vessels, which lasts after leaving a warm bath, it is best

that the bather should go to bed at once, in order to prevent sudden cooling of the skin's surface with consequent chill. If these baths are taken on arising they should be at once followed by a cold sponge or shower bath, in order to contract the capillaries. A hot bath before going to bed is an excellent measure to promote sleep, lessen nervousness, and increase the action of the sweat glands in conditions in which it is desirable to lessen the work performed by the kidneys.

Sea Bathing.

Sea bathing is an excellent mode of administering the cool bath, for, in addition to the ordinary advantages of the latter, the slight increase in respiration not only increases the consumption of oxygen, but also of iodine and bromine vapour contained in the sea air, the increased density of the salt water has a more stimulating effect upon the skin, and the constant motion of the water acts as a mild form of massage. Sea baths are best taken during the early part of the day, either before or at least two hours after breakfast, and the bather should not remain in the water too long. One bath a day should suffice, and on leaving the water the skin may be douched with fresh water and should be rubbed vigorously.

The Shower, Needle, or Rain Bath.

The shower, needle, or rain bath, supplying cold, hot, or warm water, are admirable measures for quick bathing. They combine the stimulating effect of the forcible impact of the water on the skin's surface with the advantages of the form of water employed. These baths are particularly useful in large public institutions, because no time is lost in filling and emptying a tub; it is impossible that the same water will be used to bathe more than one person, and less water is used to accomplish the same results.

The Bathroom.

If everybody could afford it of course the ideal arrangement would be to have a bathroom connected with each bedroom in a house, in order that the occupant of the sleeping apartment might step into his bath without unnecessary delay on awakening in the morning or leave the bath for his bed at night. While a water-closet in the bathroom may be a convenience, and the daily flushing of the soil pipe by the waste pipe from the bath tub is likely to prevent entrance of sewer gas, still the use of such a closet is limited to the occupant of the room, and the presence of the closet enhances the possibility of contamination of the air by sewer gas. The bathroom should always be provided with a window for ventilation with the outer air; the floor and walls are preferably tiled, and, if this is impracticable, the floor may be of hard wood with cork mats by the tub, or it may be covered with linoleum. If the walls are not tiled they should be covered with hard plaster and painted.

The tub may be made of iron, zinc, copper, porcelain, slate, marble, or tiles set in cement; iron and zinc tubs are cheapest, but are kept

clean with difficulty, the first-mentioned metal being subject to oxidation and rust; copper tubs are expensive and also troublesome to keep clean; slate or marble tubs are also expensive and cold in winter; porcelain tubs are easily kept clean, and have the advantage over zinc and copper tubs in that they can be put in place without being inclosed by a lot of woodwork, which is necessary to hide the unsightly frames of these latter. At the present day it is the custom to place all bath tubs so that there is no wooden casing to make inclosed space about them, free access being possible to dry the floor and to repair the pipes if need be.

The Bath Tub.

The tub should be supplied with hot and cold water, and the pipes should have a diameter which will permit a flow of water that will rapidly fill the tub. Each tub should have an overflow pipe of sufficient calibre to carry away the surplus water in case of inattention, and this pipe should communicate with the waste pipe between the tub outlet and the trap. The waste pipe should have a large calibre, in order to rapidly empty the water, and it should be provided with a suitable trap before it empties into the drain pipe.

Excellent rain or needle baths are now made and sold at such reasonable figures that, without extravagant outlay, they may be placed in bathrooms, and materially enhance their range of usefulness.

CHAPTER VIII.

THE DWELLING: ITS SANITARY NECESSITIES.

The essential sanitary necessities of a dwelling are good light and ventilation, the first for its intrinsic influence on the health of the individual as well as its germicidal action on microbes, the second in order to prevent the various disorders consequent upon bad air. It would seem that these conditions could easily be attained, but experience constantly shows the difficulty of obtaining and maintaining them. Besides good light and air, the house should be situated on dry soil where there is no malaria; it should be built in such a manner that the foundation walls will not admit ground water or ground air, that the walls will not admit the cold in winter or the heat in summer, and that the roof will prevent leakage; it should have, in cold climates, a well-arranged heating apparatus; there should be a sufficient supply of pure water; and there should be a satisfactory arrangement for the removal of sewage.

The Essentials.

One of the most objectionable features of cities is the crowding of houses, one being erected beside another, so that there is virtually no curtilage. The city landowner is too often desirous of making the most out of his property, and on a lot which has a frontage of fifty feet he will build three, and even four houses; as a consequence, the rooms are long and deep, and their interior parts are never properly lighted. If the property is a lot having a small frontage in a business part of the city, a twelve- or fifteen-story office building may be erected on it; this method of building exists not only in those cities of the United States in which the land available for business purposes is limited, but also in many of the smaller Western and Southern cities whose development is for the future to determine. The curtilage should be at least four times the superficial area of the house—that is, a house having a front of twenty-five feet by a depth of sixty feet should be built in a lot having an area of six thousand square feet, so as to afford air and light space on the three sides which are not exposed to the street. By law the height of no house should be allowed to exceed the width of the street between the gutters, and if the streets are wide and the air space on the sides of the house sufficient there will be free circulation of the air about the house and a purer supply introduced within the house for purposes of ventilation.

Curtilage and Height.

In various cities in the United States as well as in England the narrow streets have so interfered with traffic, and so furthered the development of disease, that the first-mentioned reason has been employed as an excuse for condemning property and broadening the streets. Wide streets, with cross streets at frequent intervals, and parks and gardens, are sanitary necessities for all cities. With wide streets and sufficient curtilage it is not likely that the residents of a city will want for light and air.

Width of Streets.

The dwelling should be built on natural ground, because made ground is likely to be damp or to contain organic matter, and consequently to produce exhalations which may infect the interior of the dwelling. A purchaser of a house should carefully examine into the character of the soil upon which the building is situated, and ascertain whether any spring or water course formerly occupied the land. As a measure of precaution to insure the disposal of ground air and ground water it is well to have a course of subsoil drain pipes running through the ground beneath the building and connecting with ventilating pipes in the walls or beside the house.

Site of the Dwelling.

All foundation walls should be laid not less than four feet below the surface of the earth, on solid ground, and, in case the nature of the soil requires it, piles should be driven, or iron rails filled in with concrete laid to prevent the walls from settling. The footing under all foundation

walls should be of concrete, not less than eighteen inches thick and extending on each side to half the thickness of the wall; or the footing may be of stones, not less than two feet by three quarters of a foot, well bedded in cement. If the foundations of the building are laid above the ground the walls should be provided with what is called a damp course, which is a sheet of lead, or a layer of asphalt, vitrified stoneware or slate, laid horizontally in the wall, in cement, not less than six inches above the ground level. In some soils it is necessary, if the house has a cellar, to excavate an ambit or blind area around the external wall.

Foundation Walls.

The area included within the walls of the cellar should be covered with a good layer of concrete and cement, so as to limit as much as possible the aspiration of ground air, which is always likely to occur when the cellar is heated by a furnace, or which may be forced in by elevation of the ground-water level. This cement suffices for the floor, but sometimes it is covered with a wooden flooring. The latter should be laid at least nine inches above the cement in order that there may be an air space between the cement and the wood so as to lessen dry rot in the latter.

The Cellar Floor.

The external walls should be of suitable material, preferably good bricks, stones, or similar material, of adequate thickness and construction, in order to keep the interior of the edifice at an equable temperature. In the northern United States the walls of dwelling houses should be at least twelve inches thick, though in southern climates and in England a minimum thickness of nine inches may be allowed; but if the dwelling house is more than fifty feet in height the walls of the first story should be sixteen inches in thickness; the rest of the wall should be twelve inches thick. Interior walls should not be less than eight inches thick, though party walls should be at least twelve inches. Party walls should be continued above the roof for at least two feet, so as to form a parapet, which will assist in preventing the spread of fire. For the latter reason a beam inserted in party walls should have at least four inches of masonry between it and a beam on the opposite side of the wall.

Walls of the Dwelling.

Bricks are porous, and not only admit air, but absorb water, which may cause dampness in the interior of the house. The inside four inches of walls way be formed of hard-burned hollow tiles, which prevent the entrance of external air, the loss of heat in winter and entrance of heat in summer, and tend to carry the ground air, if it gains access, above the house; these tiles are tied and bonded into the walls between the outer and the inner portions of the walls.

The roofs should be made of tin, tiles, slate, or some other incombustible material, so as to lessen the risk of fire, and suitable gutters should be

built along the eaves to collect the rain water from the roof. The rain water is carried from the gutters by conductor pipes or leaders, the size of which can not be absolutely calculated by any mathematical rule; a rough formula is to allow one square inch of the area of a transverse section of the pipe for each sixty to seventy square feet of roof, the area of the latter being calculated by multiplying the length by the breadth of the house. In cities rain water may be collected in cisterns, or the conductor pipes may convey it more or less directly to a sewer or beneath the sidewalk to the gutter, but in the country it must be collected or conducted clear of the house by means of superficial drains or gutters and distributed over the surface of the soil. If the conductor pipes are connected with underground drain pipes the latter become leaky and choked up by dirt and vegetation.

The Roof.

Every room should be provided with at least one window in order to furnish sufficient light and ventilation; the window should open directly into the external air, and its area should equal at least one tenth of the floor space. Each window should be constructed so that at least one half of it may be easily opened to its full extent, and the top of the window should be not less than seven feet six inches above the floor. A habitable room should be at least eight feet six inches in height from the floor to the ceiling, and there should be at least six hundred cubic feet of air space for each occupant, whether a child or an adult, although it is customary to count two children under ten years of age as one person. In each room where there is no fireplace or chimney, adequate and proper change of air must be secured by means of an aperture, transom, or air shaft, which should have a sectional area of at least one hundred square inches.

Ventilation.

In the arrangement of the interior of a house care must be exercised that halls and staircases have independent light and ventilation, for a hall that ends in a dark passage can not be properly cleansed and is devoid of the disinfecting influence of light, while a lack of ventilation will make these parts of a house a means of facilitating the exchange of foul air. In many city houses the staircase well is surmounted by a skylight in the roof; this should be connected with ventilators, which will facilitate the removal of foul gases and impure air, and it is a better arrangement to have the kitchen and sanitary offices on one side of the staircase, while the living rooms are on the other side. It was the custom in the Southern States to place the kitchen and privies in buildings disconnected from the house. A suitable hood placed over a stove or range, connected with a flue running alongside the chimney and provided with a ventilating cowl, will materially aid in removing the odours of cooking.

Arrangement of the Interior.

The question of the water supply of a dwelling has been discussed, but

mention may be made here of the desirability of having the supply pipe as it enters the house furnished with a cut-off and drip pipe, so that in case of accident or in cold weather the main supply of water can be cut off and the house pipes may be emptied of their contained water by means of the drip, one or more faucets at the top of the house being opened so that the pressure of air will force out the water. All supply pipes in the house should be exposed or placed in a cavity in the wall which is covered by easily removed woodwork that will permit of access to the pipes. There should be but one main supply pipe, the pipes for each floor connecting with it as branches, and it is often a matter of convenience to have a cut-off cock at each floor, so that in case repairs are necessary the water supply for the floor may be discontinued without interfering with that for the house. All traps should be of drawn rather than cast lead or of brass, their inside surfaces should be perfectly smooth so as to avoid retaining organic matter, and they should be so made that they can be easily removed. The brass traps should be carefully examined for any sand holes in their partitions.

Water Supply.

All sinks should be spacious, and those that are porcelain-lined or of stone or slate are more easily kept clean than those of iron, copper, or zinc. The sink should not be inclosed by woodwork, and there should be a piece of stone or metal, the same length as the sink, placed against the wall at the top of the sink in order to prevent wall-wetting. The waste pipe of the sink should be two inches in diameter, to facilitate self-cleansing; it should have its aperture protected by a perforated cap, in order to keep coarse particles from entering and clogging the pipe, and there should be in the latter, beneath the sink, a suitable trap which can be removed and cleansed of grease. Sometimes the grease is collected in a grease trap, which is a tank made of stoneware or metal, having inlet and outlet pipes which have their apertures beneath the level of the water in the tank; the grease collects on the surface of the water and is removed from time to time.

While the removal of liquid and solid refuse will be considered in a subsequent section, it is appropriate to mention here the arrangements which are in ordinary use for receiving the excretions of the human body, such as the ordinary water-closet apparatus, dry-earth closets, and privies of various kinds. Every closet of this description should be so arranged that it is effectively ventilated. In cities the water-closets are most common; these consist of the pan closet, composed of a conical basin in which a pan at the lower aperture is tilted by raising a handle and the contents are thrown into a receiver, whence they fall into a trap that passes on to the soil pipe. Valve closets consist of a basin from which

The Removal of Excreta: Water-closets.

the water is emptied by raising a valve by means of a handle in the seat; this variety is now rarely employed in the United States. The flushing-rim, long-hopper closet consists of a long conical bowl into which the water is discharged by a flushing-rim placed at the upper edge; the excreta hang about the sides and a large quantity of water is required to cleanse the basin. The wash-out closet has a basin that empties into a trap, one arm of which is constantly open and exposed to the air; the water enters this basin in a direct downward stream, which drives everything before it, but the exposed arm of the trap may be smeared with fæcal matter, or fæces may not be flushed out of the water in the trap, and there is not infrequently some odour about such a closet. The wash-down closet has a hopper-shaped bowl, the small extremity of which forms, with the soil pipe, a U-shaped trap; this is a satisfactory model and does not require a large quantity of water.

A good water-closet should be free from odour, easily flushed, simple in construction, so that it is not likely to get out of repair, and the soil pipe should be properly ventilated. White glazed earthenware is better than enamelled iron for the basin, which should contain a sufficient quantity of water to prevent smearing and should be so shaped that the excreta will fall directly into the water. The water should enter the basin with sufficient force to thoroughly cleanse it, a fan-shaped piece of metal being sometimes placed opposite the inlet so as to spread the water over the entire surface, and the water should flow from a flushing cistern placed four or five feet above the closet basin. Various plans have been proposed for the purpose of automatically disinfecting water-closets, but if the closet is properly constructed disinfectants are not required. Mr. W. P. Gerhard calls attention to the facts that where porcelain water-closets are used the floor-joint, which is on the soil-pipe side of the trap, must be tight, and the connection between the earthenware arm of the bowl and the soil pipe must not be made of too rigid material, or the slightest settlement of the floor will break the earthenware.

In the country there are better means of disposing of excreta than the water-closet, as has been ably and forcibly portrayed by Dr. George Vivian Poore in his very interesting *Essays on Rural Hygiene*. Dr. Poore says: "Since the introduction of the water-closet, and probably as a direct consequence of it, we (the English) have had four severe epidemics of cholera, a disease not previously known, and enteric or typhoid fever, previously almost or quite unrecognized, has risen to the place of first importance among fevers in this country." He urges that the rule of Nature which most affects health is that all refuse matter shall be restored without delay to mother-earth; and he quotes Mr. Charles Richardson, a civil engineer, who speaks of the great progress in scientific discovery and invention made during this century; but in the midst of

all the beneficial inventions during the period was one wholly evil—the water-closet.

Dr. Poore's fundamental maxim is that excrement should never be allowed to come into contact with water; closed sewers should only be resorted to in cases of the direst necessity and with a full sense of their danger, while a cesspool is the most immoral of all insanitary subterfuges, the pressure of the contained water being sure to force an outlet and contaminate the underground water. So Dr. Poore advocates the more general employment of the earth closet, and his long experience has proved the correctness of his judgment.

Earth Closets.

Dr. Poore advises that an earth closet should be in a building either distinct from the house or approached by a short passage or corridor that has cross ventilation, and the apartment should be lighted from the top, in order that any impurity might be noticed at once, while a concrete or tile floor furthers cleanliness. Beneath the seat there is a galvanized-iron receptacle, which is placed in the same spot by means of guides fastened to the floor, and which may be removed from the front, back, or sides. The earth should be stored in a bin alongside the seat, and should be thrown upon the dejecta by means of a flour scoop, rather than by a mechanical contrivance which always throws the earth on exactly the same spot; and under no circumstance should the earth be artificially dried by heat, as sifting and storing it in a shed a few weeks before it is needed will make it dry enough. The receptacle should be emptied daily, the contents placed in a shallow trench in a field and lightly covered with earth, so that microbial action will soon reduce the whole mass to the condition of garden earth or humus, which may be used again and again in the closet, and when ripe it is earth, not manure, that is unsurpassed for horticultural purposes. Garden earth or humus is the best kind of earth to use in such a closet, because it contains large numbers of microbes which quickly change the organic matter; earth taken from a considerable depth and ashes are sterile. The interchange between the earth and the organic refuse is quickest in ordinary summer weather, when it is accomplished in about three weeks, and it is delayed or checked by cold or drought; during the process the earth should be stirred over occasionally.

The Dry Privy.

Where the earth closet is not used a dry privy may be constructed; there is no pit, the privy being built above the ground and entered by means of one or two steps. A box of dry earth may be kept in the closet and a scoopful be thrown upon the excreta; if the mixture of earth and excreta is turned over from time to time, and there is a sufficient quantity of dry earth used, there will be very little odour. From a hygienic standpoint it is absolutely essential that the dry earth should cover the excreta sufficiently to prevent flies

crawling over it, and thence carrying away micro-organisms with which food stuffs may be infected.

Soil Pipe.

Where water-closets are used the pipe which connects the closet with the sewer is called the soil pipe, and all the waste-water pipes of the house are likely to empty into it. These pipes are made of drawn or cast lead, of zinc, of earthenware, of cast and of wrought iron. Lead, zinc, and earthenware pipes are undesirable, and not often used for the purpose. Cast-iron pipe is likely to have sand holes or imperfect seams, therefore each piece should be tested at the foundry by hydrostatic pressure; and in order to prevent oxidation of the interior of the pipe, with consequent retention of fæcal matter on the rough surfaces, the pipes should be protected by a thorough coating of coal tar, or by dipping the pipes while heated into a bath of asphalt, or they might be galvanized, or made impervious to rust by some method, such as the Bower-Barff process. Sanitary engineers favour wrought-iron pipe of about four inches diameter for an ordinary dwelling, with screw joints, so that the risk of lead-caulked joints may be dispensed with. In England and in some parts of the United States it is customary to place the soil pipes outside of the house, but in most parts of the United States the climate is too severe in winter to permit of such an arrangement. If a soil pipe is properly constructed, and this may be determined by testing it, if it is carried well above the top of the house and its open extremity is provided with a ventilating cowl, so as to increase the outward flow of air, if the soil pipe is connected with the sewer pipe by means of a curved bend, so that the flow of sewage from one pipe into another is not impeded, and if all waste-water pipes which empty into the soil pipe are properly trapped, there is no objection to the presence of the soil pipe within the house. Sewer air does not behave in a manner different from other air, it does not have special laws of diffusion, and it is likely to escape in the direction of least resistance when dammed back, and so will escape through the pipe in the roof.

House Drains.

While it is held by sanitarians that no drain which receives sewage should traverse the basement of a house, this pipe, like the soil pipe, must usually be included in the interior of a dwelling. Formerly a drain pipe was buried beneath the cemented floor of a cellar, where it was practically inaccessible. Now it is suspended from the ceiling or carried along the side of the cellar wall, where it may be easily inspected. Sometimes, in order to secure drainage, the drain pipe is placed in a brick and concrete trench below the level of the cellar floor; but such trenches are likely to harbour vermin and accumulate dirt and moisture, so it is preferable to embed such a drain in concrete and have manholes or hand-holes for inspection purposes at either end of the embedded section. Cast-iron or wrought-iron pipes are preferable to

glazed earthenware pipes for such drains; the former pipes should be lead-jointed, coated inside and out to prevent corrosion, and in part of their course there should be cast-iron intercepting traps or hand-holes.

Drains should always be laid in straight lines, a bend being made by means of a pipe that has the desired curve. If the gradient of a house drain is low it is advisable to connect an automatic flush tank with the head of the drain, so as to prevent any blocking of the pipe by a deposit.

Stationary Wash Basins.

The stationary wash basins in a house may be tip-up basins, in which the bowl is supported on pivots and the water is emptied into a receiver by tipping the basin, but the receiver is not easily cleansed, and is likely to become foul. The chain-and-plug basin consists of a bowl from which the water is emptied by a waste pipe, the aperture of which is closed by a plug attached to a chain; one of the objections to this basin is that it may overflow if the overflow pipe at the top of the basin becomes plugged, the chain collects dirt, and the waste pipe is too often fouled by pins, buttons, threads, and other small articles dropping into it. The open stand-pipe overflow and the secret waste-valve basins have objections that need not be considered here. The waste pipe should be trapped below the basin, and again by a U or S bend just before it enters the soil pipe.

Washtubs.

Washtubs in the kitchen or laundry of houses should be made of stone, slate, or enamelled iron, the tub standing away from the wall so that it may be accessible on all sides. Wooden or zinc-lined tubs should not be used. The tubs should stand at such a height above the floor that their traps may be easily removed and cleaned, and this should be done at regular times, because the traps are sure to collect lint, thread, and buttons from clothes.

Traps.

A trap is an appliance in some part of the course of a drain or sewer pipe, and is used to exclude from a house the foul air produced in drains or sewers. A trap may be useless in consequence of being improperly laid, or because of leakage, or as the result of the collection of sediment; so all traps should be provided with means for examining their interiors. The retention of water in the trap prevents the passage of sewer air, and if the flow of waste water is infrequent the trap may become unsealed in consequence of evaporation, which may be furthered by the heated air of the house; or if the soil pipe or drain is not ventilated by an aperture opening into the air, there may be a backward pressure of sewer air, which will force it through the water in the trap, or so impregnate the trap water with it that the foul air is given off in the house. The experiments of Philbrick and Bowditch showed that the momentum of falling water helped the air draft to siphon most of the different kinds of traps, even when the top of the soil pipe was open; and the siphonage could be prevented by introducing

air at a normal pressure at the crown of the trap by means of a ventilator pipe. While the plumbing regulations of several cities besides New York require that all traps must be back-aired or ventilated, yet, as Mr. W. P. Gerhard has indicated, this necessitates a complicated duplicate system of pipes, which is expensive, and has the risk of increasing the number of pipe joints. If non-siphoning traps are used, and all the fixtures are located directly at or within a short distance of the lines carried up to the roof, siphonage is unlikely to occur under any ordinary condition. It has been found that it is safer to connect the waste pipes of baths, basins, sinks, etc., directly with the large soil pipe by Y-branches located as near as practicable to the fixtures drained than to place long lines of smaller-sized wastes separately. The larger the soil pipe the less the risk of any abnormal air pressure occurring by its use, so long as it is not likely to become encumbered by the accretion of solid matter.

Large drain pipes, however, are undesirable; a four-inch pipe will suffice for a small dwelling, a five-inch pipe for an ordinary four-story city house, and a six-inch drain for a large residence.

English sanitarians advise, in order to prevent the passage of sewer air into a house, that the waste pipes be absolutely separated from the drains, emptying outside of the house over trapped gullies. While the existence of an open space of at least eighteen inches between the end of the waste pipe and the trap lessens the possibility of sewer air gaining access to a house by means of the traps, such an arrangement is impracticable in the colder parts of the United States.

Testing Plumbing.

All plumbing work should be tested by a qualified sanitary engineer before it is accepted. For all new work the water test and the air test should be tried not only on the main vertical and horizontal lines, but also on all the branches. The water test is applied by plugging the lower end of the pipe, and then filling the pipes with water, and the pressure will force the water through any imperfectly closed junctions. The air test is applied by forcing compressed air into a plugged pipe. Imperfections in the joints or traps may be discovered by the smoke test, in which smoke is pumped into the pipes, or a rocket which burns and produces a large quantity of smoke is placed in the lowest portion of the soil pipe. Oil of peppermint may be poured into the top of the soil pipe, and its pungent odour will be perceived at any trap or joint which is imperfect. In moving into a house it is well to apply the peppermint test to the plumbing; the general line of water supply and drainage should be observed, and all joints should be inspected to learn whether there is any moisture indicative of leakage about them. An examination of the waste pipes from bath tubs, stationary washstands, sinks, and washtubs should be made, and all the traps opened, examined, and cleaned, if necessary. The overflow pipes should be examined, tested

by pouring water into them to prove whether they are open or occluded, and it should be noted whether they enter the waste pipe between its outflow aperture and the trap. The flushing tanks of water-closets should be examined to see whether they are clean and work freely. Avoid having woodwork about plumbing, and see that all fixtures are easily accessible. Old lead pipes may be painted or bronzed, and are much more easily kept clean and bright than the nickel-plated plumbing. Mr. Gebhard recommends in preference to the latter that the piping be electro-copper bronzed or finished in oxidized silver, so as to do away with the need of constant polishing.

CHAPTER IX.

THE DISPOSAL OF REFUSE.

Definition of Refuse.

The refuse of a community includes the fæces and urine of men and animals, which, with the waste water from washing and cooking, constitute sewage, and the ashes, dust, refuse food, fragments of fabrics, paper, metal, wood, glass, stone, and crockery, and the sweepings of the streets, which constitute garbage. No question is of greater importance to a community from either a sanitary or an economic standpoint than the best methods of disposal of sewage and garbage; and as Alexander solved the problem of untying the Gordian knot by cutting it with his sword, so civic communities have, as a rule, solved the problem of sewage and garbage disposal by emptying these waste products into the nearest water course. This method has entailed great expense in the construction of sewers, the necessity of supplying large quantities of water, and of the employment of labourers and vehicles to remove garbage; it has polluted water courses, filled up the beds of streams, and strewn the banks or shores with decaying organic matter and *débris* of various kinds. Only allow a community to get rid of its own sewage and garbage, and no thought is given to the effects of these substances on other neighbouring communities; in this matter our acts show that we do not think we should be our brother's keeper.

Sewage.

An adult male, living on a mixed animal and vegetable diet, is estimated by Lawes to pass four ounces of solid fæces and forty-five ounces of urine *per diem*. When fresh, about one fourth of the fæces and one thirtieth of the urine are dry solids. Of an equal weight of urine and fæces, the latter is more valuable as a manure, although the urine passed in twenty-four hours is ten times as

valuable for fertilizing as the fæces passed in the same time. Dr. G. V. Poore estimated that in London about two hundred tons of most valuable manure ran to waste in the urine passed daily by the inhabitants of that city, while Messrs. Lawes and Gilbert calculated that the money value of the chemical constituents of the annual excretion of each individual of a mixed population was two dollars and five cents (8*s.* 5¾*d.*). As it is impossible to collect fæces and urine without including other substances, the money value of the excreta of an urban population can not be realized.

Besides the substances just referred to, sewage contains kitchen slops, or water containing soap, grease, and the washings, or a solution of animal and vegetable matters; bedroom slops, consisting of water, soap, and dirt from the body and clothing; the waste water from manufactories; and often the rain-water washings of the roofs of houses and the streets. Sewage may be removed by the water-carriage system, by Liernur's, Waring's, or other systems, or by conservancy methods.

Water-carriage System.

By the water-carriage system all sewage is removed from the house by drains connected with sewers constructed on the separate or the combined systems; in the former the surface and the subsoil water are removed by one set of pipes and the sewage by another, while in the latter system the sewers are constructed of such capacity that they will carry off the rain and subsoil water.

Separate System.

The pipes for sewage in the separate system are of glazed stoneware or concrete, circular, and have diameters varying from six to eighteen inches, according to the population of the districts in which they are located. These pipes must be carefully tested for flaws, cemented at the joints, and laid on a firm bed of concrete at a gradient sufficient to afford a velocity of about three feet per second. There should be a properly curved junction between smaller and larger pipes, so that there will be no deposit on the wall of the pipe, and the interior of the pipes must, when they are laid, be kept free from all cement or *débris* that might obstruct the flow of sewage. A manhole should be built where a tributary joins a main sewer, so as to permit the examination of the pipes in case of obstruction or defect. These pipes have been laid with tile drains upon them or upon ⌓ - shaped subsoil drain and pipe rests, which serve to drain the subsoil water. The main outlet of this system is a brickwork sewer. All rain water is allowed to filter into the soil, or is conveyed into underground drains, which discharge into the nearest body of water.

In this system the volume of sewage is much less than in the combined system, the quantity can be estimated with fair accuracy, and the composition is uniform, it is easily inspected and flushed, and its cost is

less than that of the combined system. It is especially economical if the sewage has to be pumped to an irrigation field.

The Combined System.

Sewers intended to convey house and manufacturing sewage as well as rain water must be of moderately large dimensions. While twelve- or eighteen-inch pipes may be used to carry the sewage from cross streets in residence localities, the main sewers must be built of a circular or ovoid shape, the small end of the ovoid downward, in order that there may be less friction, and that the liquid may have a greater depth when the volume of sewage is small. The circular form is used for outfall sewers, where the volume of sewage is large, because of its greater strength and cheapness. These sewers should be constructed of curved glazed bricks or blocks laid in cement, and the lower segment of the sewer embedded in concrete; the brickwork of a sewer under three feet in diameter may be 4·5 inches thick, for larger sewers it should be nine inches thick, and in bad ground two courses of brickwork are required.

The gradient of a combined sewer should be sufficient to produce a velocity of not less than two and a half nor more than four and a half feet per second, a less gradient being required to produce the same velocity in a large than in a small sewer. Drains and small sewers should always join large sewers at an angle which follows the direction of the flow of sewage. The radius of a curve should not be less than ten times the sectional area of the sewer. Manholes should be built over the sewers at regular intervals and at all junctions and changes of direction, so as to allow of inspection and cleaning.

The arrangement of the outfall of a sewer will depend upon the disposal of the sewage by direct discharge into some body of water, or by chemical treatment, or by irrigation, or by pumping. If sewage is to be treated chemically, a duplicate series of settling tanks, varying in number and size according to the volume of the sewage, must be constructed. When it is to be purified by irrigation the sewage may flow to the irrigation farm by gravitation, or it may have to be pumped from a storage tank or reservoir at the outfall. Where sewage is discharged into a water course the sewer should be carried far enough out to be covered by the water at all stages of height.

Ventilation of Sewers.

Free ventilation of sewers is necessary in order to prevent the concentration or stagnation of sewer air, which sometimes contains fetid gases, such as sulphuretted hydrogen, carbon disulphide, and compound ammonias, organic vapours containing ptomaines and leucomaines, and microbes. The apertures at the manholes are used for ordinary sewer ventilation, the velocity of the flow of the sewage tending to create a current of air in the same direction. Any increase in the volume of sewage naturally diminishes

the quantity of air, a sudden heavy rain producing manifest expulsion of sewer air. If steam from manufactories or hot liquids are discharged into sewers there is an expansion of sewer air, which may be discharged through the nearest opening or may be forced into the drain pipes of houses. A sewer without ventilators, or one in which these apertures are choked up, is dangerous because its air may be forced into the drain and soil pipes of houses and find its way through defective joints or traps.

If a sewer is well flushed and free from obstruction the direct ventilation just referred to suffices; but if the air from a manhole ventilator has any odour it is likely that there is a deposit in the sewer which should be removed by flushing. Filtration of sewer air, the use of deodorants and of elaborate systems of ventilation, are valueless.

Ventilation is much more easily secured in the combined than in the separate system of sewers; in the latter the sudden entrance of a volume of water causes greater displacement of air than in a large sewer, and the air has no chance to escape. Ventilating pipes carried above ground may be placed at inspection manholes at convenient distances.

Flushing Sewers.

In badly constructed sewers, as well as in sewers in which there is a small quantity of fluid in proportion to solids, there are likely to be deposits of semisolid organic matter from which there are offensive gaseous and organic discharges. In order to obviate this the sewers should be flushed systematically. This flushing is accomplished by means of flushing gates, attached at the sites of manholes and covering the whole or a sectional area of the sewer. When these gates are closed the sewage is dammed back, and when they are opened the volume of sewage flushes the sewer below with a velocity which is proportional to its head.

Sometimes automatic gates, hinged below the centre, are used, the gate remaining closed until the sewage rises to a point on the upper surface where the pressure is so great that the gate tilts forward in a horizontal position, thus liberating a volume of sewage, the flushing gate returning to its position as the sewage falls to a normal level.

Small sewers may be flushed by pumping water into them by a fire engine. The flushing is required most during the summer months and periods of drought.

The Liernur System.

C. T. Liernur devised a system in which each house is provided with one set of drains for removing fæcal matters from air closets, and another set for disposing of rain and household waste water. The former set is connected with pipe drains in the streets, which discharge into the nearest water course. The closets consist of hoppers with siphon traps which are connected by means of soil pipes with street sewer pipes emptying into small air-tight tanks; the latter communicate with larger tanks, which are connected

with a central tank at the sewage works. By means of powerful air pumps, and on opening valves in the street sewers, the sewage is sucked along the pipes, and, as it contains but a small amount of water, it is concentrated by heat, dried in revolving cylinders, and used for fertilizing purposes.

The Berlier, Shone, and Waring Systems.

The Berlier system is similar to the Liernur system in its use of separate drains and of an air vacuum, except that it dispenses with valves which must be worked by hand, each house drain emptying into an air-tight receptacle which, when full, is opened automatically by a floating valve, and allows the sewage to be sucked away.

The Shone system is intended for use in level countries, where sewers can not be laid with any, or very slight, gradient. The street sewers empty into fairly large air-tight receptacles, out of which the sewage is emptied by compressed air. The method has been found very satisfactory in the towns in which it has been employed.

The Waring system is a system of separate sewage removal, in which an automatic siphon flush tank is located at the dead end of each branch sewer. The tank is built of brick and concrete, and is situated below the level of the street; it is filled from the water mains, and the water is discharged by an annular siphon into a box beneath the tank, which is connected with the sewer. A manhole is located over the mains at each interval of five hundred feet; and ⊥-pieces in which the upright stems reach the street level and are covered with lids should be inserted at intervals in order to allow for cleaning.

The Conservancy System.

The use of privies or middens is so general throughout the world that its disadvantages are familiar to all. Leaky and fetid privies and midden heaps composed of accumulated excrement are a constant menace to health. A privy should be at least ten feet away from a dwelling, and from fifty to one hundred feet away from a well; it must be roofed over to exclude the rain and provided with ventilating apertures beneath the roof. The floor of the privy should slope toward the door, and at its lowest part it should be at least six inches above the ground. The receptacle under the seat should be constructed of nine-inch brickwork set in cement or asphalted, its floor should be three inches above the ground level, and its capacity should not exceed eight cubic feet. The contents of the receptacle should be kept dry by throwing dry earth upon them; no slop waters should be thrown into it.

Such privies as have been described are more conveniently cleaned if pails are substituted for the impermeable trough receptacle. The pails should be of galvanized iron, provided with a heavy lid to prevent leakage, round in shape, so as to be easily cleaned, and have a capacity of

ten gallons. These pails may be removed two or three times a week, and in communities where a number of people use the system a scavenger may be employed to collect the filled pails and return the empty ones. No kitchen slops or garbage should be thrown into the pails, and the contents are less offensive if dry earth is thrown in; ashes or charcoal are less satisfactory, as they interfere with the fertilizing value of the excreta, although these substances are good deodorizers, and must be used in large communities where it would be impracticable to supply enough earth.

Pail System.

A cesspool, properly speaking, is an excavation in the soil which is intended to receive fæcal matter, kitchen slops, and other liquid waste from a house. The use of water-closets in houses in suburban or rural localities, where there are no sewer connections, has popularized the construction of cesspools. In the course of time the cesspool is likely to become an intolerable nuisance; its contents, both liquid and gaseous, percolate into the soil and contaminate the subsoil water and the products of their putrefaction pollute the air. When the cesspool is full its contents must be pumped out and the matter conveyed somewhere, the difficulty of disposal increasing with the volume of contained sewage.

A Cesspool.

In some American cities—for example, New Orleans—and in many European cities, cement-lined cesspools are built in the yards of houses, sometimes two being built side by side, so that the solids are retained in one and the liquids flow over into the other. Each cesspool has a ventilating pipe that reaches above the roof of the house. They are emptied by pumping their contents through an air-tight hose into a cart holding a tub like a street sprinkler. In Europe a somewhat similar cart is used, which is connected with a small engine that extracts the fetid gases from the cesspool and burns them in its furnace, and at the same time creates a vacuum in a metallic tank on the cart. The contents of the tanks may be discharged on land, or carried to a crematory, or otherwise disposed of.

In country districts in which each house has sufficient yard territory excrement can be safely and advantageously disposed of in the garden, as has been urged by Dr. Poore. But where a country district is fairly well populated the removal of excrement by the pail system is quite an expense, for the greater the distance that such manure must be carried, the greater becomes the expense of supplying it. There is the sanction of antiquity to the earth system. Deuteronomy, chapter xxiii, verse 13, directs: "And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself abroad, thou shalt dig therewith and shalt turn back and cover that which cometh from thee." Such undoubtedly is the true application of the idea earth to earth.

The Earth System.

Only an enactment by the General Government of the United States, under the public-welfare clause of the Constitution, could secure such legislation as has existed in England since 1876, in virtue of which it is illegal to discharge crude sewage into any river, water course, or lake. But in the nineteen years that have elapsed since the enactment of the law it has been impossible to enforce generally its provisions in Great Britain, and the difficulty of doing so in the United States may be imagined.

Protection of Water Courses.

Where the volume of sewage is small in comparison with the volume of water of the running stream, the oxidizing effect of air and sunlight aid in destroying organic matter; there is a partial deposit of the coarser matter in sewage, and animalculæ and bacteria aid in converting the organic matter. As a result of these factors, streams receiving sewage have been found free from chemical or bacterial taint some distance beyond the sewer outfall. But if the stream is small, or if its volume is materially decreased in warm weather, or if there are fresh accessions of sewage from towns situated within a few miles of each other, but little self-purification can take place, and the pollution increases from the source to the mouth of the stream. The bed and banks of the stream are covered with a deposit of decaying sediment, and fermentative processes exist in the water saturated with organic matter. In warm weather this is a great nuisance, the water is unfit for use, and public health is menaced.

The discharge of crude sewage into any water should be prohibited, as the sewage may be purified by precipitation, filtration, or irrigation.

If sewage is allowed to settle in tanks the suspended matter gradually subsides to the bottom, leaving a more or less clear liquid at the top; but this is a slow process, and in order to expedite precipitation, chemical agents have been added to the sewage before it enters the settling tanks. A large number of chemical substances were employed for this purpose, and fictitious values were assigned to the fertilizing value of the precipitate; but most of the processes proved to be signal failures, experiment showing that chemical precipitation of insoluble and soluble organic matter did not produce a material that was of sufficient value to justify the increased cost.

Precipitation Process.

In order that precipitation may afford the best results, it is requisite that the sewage should be delivered fresh, and at once mixed with the chemical before it is discharged into the tanks. The latter should be at least four feet in depth, and arranged in duplicate series, so that the effluent may pass over weirs half an inch beneath the surface. The tanks must be emptied and cleaned at regular intervals, and the sludge may be conveyed to fields, where it is buried for fertilizing purposes, or it may be compressed into solid cakes in a hydraulic press, the sludge often

being mixed with road sweepings; the value of these cakes as manure is a fraction of the cost of their production.

Precipitating Agents.

The best precipitating agents are lime, alumina sulphate, and iron protosulphate. Lime combines with the carbonic acid in water, forming an insoluble calcium carbonate, which is precipitated and carries down with it much of the suspended organic matters in sewage, but the organic matter and ammonia in solution are unaffected. If too much lime is used the sewage becomes alkaline, and fermentation is increased.

Alumina sulphate combines with calcium carbonate in sewage, forming calcium sulphate and aluminum hydrate, which is precipitated, carrying with it most of the soluble and some of the suspended organic matters. Sometimes lime and alumina sulphate are combined.

Iron protosulphate acts best in an alkaline sewage, and it is often used in conjunction with lime; it oxidizes organic matter, and retards putrefactive processes in the sewage.

The clarified effluent contains a large quantity of organic matter, and it should not be allowed to enter a stream until it is further purified by land filtration or irrigation.

There is no precipitation process that utilizes sewage to any advantage, and as it incompletely purifies sewage, it is not to be recommended.

Filtration Processes.

Investigation has shown that sewage is purified if it is passed through porous soil, the best results being obtained by filtration from above downward, as upward filtration does not remove all the soluble organic matters. The soil acts as a mechanical filter, retaining the suspended and precipitating the soluble organic matters, which are oxidized and converted into carbonates, nitrites, and nitrates. The soil should be porous, so as to permit of free aëration, without which there can be no oxidation; it must not retain too much water, it must be level, and the area must be sufficient for the quantity of sewage. At least an acre of land must be allowed for each thousand of population, for a large volume of raw sewage applied to a small area of land clogs the surface and water-logs the subsoil. The difficulties of this method of filtration are met by irrigation.

Mr. George W. Fuller, in his report upon the purification of sewage by filtration published in *The Twenty-fifth Annual Report of the State Board of Health of Massachusetts*, says that sewage filters resemble complex living organisms in that ventilation and respiration must be maintained, otherwise their functions are interrupted and their lives as filters come to an end. A portion of the insoluble matter or sludge is deposited upon or near the surface of a filter through which sewage passes, clogging up the surface, interrupting ventilation, and deteriorating the purity of the effluent. With filters of suitable material more than one hundred

thousand gallons per acre may be purified daily, with a removal of over ninety per cent. of the organic matter, the permanency of the filter being independent of the size of material, but directly dependent upon the treatment of the filter bed. Filters in operation for six years showed that there was practically no more nitrogen stored in them at the end than at the beginning of the year.

Mr. Fuller's investigations showed that systematic raking, with occasional harrowing or ploughing of the bed, was very satisfactory, especially for coarse materials; that systematic scraping, followed by raking, gave good results for fine materials, though the scraping was inadvisable unless associated with raking or harrowing; that the efficiency of very fine material was increased by trenching with coarse material, the size of which should be carefully graded to prevent clogging; that allowing a filter bed to rest for a limited time facilitated the removal of stored organic matter; and that the capacity of filters should not be taxed during the winter months to such an extent that more organic matter is stored throughout the sand than can be removed during the high nitrification which goes on during the spring and summer.

Filtration of sewage through coarse gravel at a rapid rate, and with the aid of a current of air drawn through the gravel, consumed sludge to a large extent, and gave the greatest purification of the effluent water. And if the sludge is first removed by sedimentation, filters of finer material may be operated at a more rapid rate than if ordinary unprecipitated sewage is used.

Irrigation.

Sewage may be disposed of by irrigation over or beneath the soil's surface. Where plenty of land is available and sewage can be conducted to it by gravity, surface irrigation is the simplest and cheapest mode of disposal. The acreage must be sufficient, that the sewage may be applied to the fields intermittently in order to insure sufficient aëration of the soil and to prevent the land from becoming water-logged. The soil should be loose and porous, and if it is clayey it must be broken up and mixed with ashes, sand, or lime; it must be well drained, and the quality of the soil will indicate the area available for the number of inhabitants.

The outfall sewer should be conducted to the highest point on the land, the sewage should be passed through a screen so that all large, solid particles may be removed, and it should then be allowed to flow by gravity through open masonry or concrete gutters placed along the tops of ridges, whence it may be distributed through sluices to the surface of the ground.

The irregularity in the volume and the degree of dilution of the sewage is a disadvantage in the use of the irrigation system, and interferes with the value of the crops that are produced. The experience of Eng-

lish sewage farms is that there are practically but three crops—Italian rye grass, cabbages, and mangolds—which are not injuriously affected by sewage; and of these, Italian rye grass has been found to be the best because it flourishes in a quantity of sewage that would kill most other plants, from five to seven cuttings being obtained in a year, and it purifies the sewage day and night, in wet weather and in sunshine. When cut, however, this grass does not keep well or bear long transportation, and it is only converted into hay in dry, warm sunshine. As sewage contains all the fertilizing ingredients the soil requires, land to which sewage has been applied is far more productive than other land in the same neighbourhood. In France, Germany, and England sewage irrigation has transformed barren wastes into fertile fields; and the more thorough the percolation of sewage through the soil, with intermission to prevent too large a quantity in each irrigation field, the better are the crops and the purer is the effluent water.

An irrigation farm may become a nuisance if the sewage is decomposed when it arrives, or if the conduits are used permanently so as to allow of the deposit of sewage on their bottom and side, or if the sewage is improperly distributed, or if there is inadequate subsoil drainage and consequent stagnation of water on the surface of the field. There is no evidence from any locality where sewage farms exist that these establishments are likely to affect injuriously the health of man or animals.

Subsoil Irrigation.

The subsurface irrigation system consists in carrying the sewage in an air-tight conduit from the house to a sewage or flush tank. The latter should contain two chambers, the first being used to retain the solids and kitchen grease, while the second and larger tank receives the liquid sewage from the first tank by means of a deeply trapped overflow. By means of an automatic siphon the liquid sewage is discharged once or twice a day into an outlet pipe that leads to the irrigation field. The main conduit to the field should be a water-tight drain pipe which connects with a two-inch porous drain pipe that has a system of lateral absorption drain tiles, laid with open joints, in trenches twelve inches deep, at a gradient of from six to eight inches in one hundred feet.

Subsoil is less preferable than surface irrigation for the disposal of town sewage, but for rural houses, or even small groups of houses, where the sewage purification would have to be effected on land adjoining the residences, subsoil irrigation may be more suitable.

If there are not enough absorption tiles the field is likely to become water-logged, or if the gradient is too steep the bulk of the sewage runs to the lower end of the field, or the tiles may be laid too deep and the sewage does not gain access to the upper layers of the soil, or the tank may have but one chamber and the tiles soon become choked.

In many manufacturing districts in the United States water courses are polluted by the waste from factories. This may be liquid or solid, and may contain poisonous substances, dyestuffs, oils or fats, or solid matter which is likely to clog up a stream. The liquid refuse could be precipitated, or it might be disposed of by intermittent downward filtration in a suitable soil. The latter would probably be unfit for agricultural purposes. Solid refuse should be cremated.

Manufacturing Refuse.

The solid refuse of a city consists of garbage, ashes, general rubbish, market and manufactory refuse, and street sweepings. Most of this refuse being in a more or less solid condition, it is removed by a municipal scavenging department; but the proper disposal of the collected material is a problem which is receiving attention throughout the world, as it involves important sanitary and economical features. The main question to be decided is the best sanitary disposition of refuse; and if the expense of such disposal can be reduced by utilizing a part or all of the refuse, the community is correspondingly benefited.

Disposal of Solid Refuse.

Refuse may be divided into two important classes—waste organic and inorganic material. The first consists of scraps of food, offal, and decaying animal and vegetable substances; the second of ashes and cinders, household dust and rubbish, etc. The dust and ashes are unlikely to give rise to nuisances, although their retention on premises may be inconvenient; but the organic matter will ferment, putrefy, and cause decided nuisances.

In some cities in the United States there is a municipal system for collecting all refuse, in others only the organic garbage is collected, while in others each individual must arrange for the disposal of his waste and refuse. There is a great difference in the character of refuse, and this necessitates different plans for its removal.

If it was possible to have each household cremate its kitchen garbage the problem of disposal would be easier. Dr. S. H. Durgin, of Boston, has invented a very simple apparatus for this purpose. It consists of a perforated sheet-iron cylindrical basket which has a tight bottom and a capacity of three or four quarts; this is inserted into an expanded box in the stovepipe, and allows the hot air and smoke to pass on all sides of the basket, drying the contents and carrying the odours out of the chimney. The basket is easily withdrawn and will receive garbage from time to time as it is made in the routine of kitchen work; without extra fuel the garbage is dried to charcoal, and Dr. Durgin states that the latter may be used to start a fire in the morning. In some houses it is the custom to throw all organic matter into the ash box of the kitchen range or the furnace; this sometimes results in the odours penetrating the house,

and the upper surface of the refuse may be incinerated, while the surface resting on the floor of the ash box remains moist.

Where natural gas or coal oil are used as fuel, a small tightly covered iron box, which has a pipe connecting with a flue to carry off the odour, may be used to cremate kitchen garbage.

It is generally recognised by sanitarians that dry and moist refuse should not be mixed, as is the case in New York city, the ash can being the receptacle for kitchen refuse, ashes, and rubbish of all kinds. It is true that there is an ordinance prohibiting such a mixture, but its provisions are not enforced. Kitchen refuse should be separated from ashes and other dry rubbish; this is easily accomplished by having separate pails or galvanized-iron ash cans for the receptacle of each kind of garbage. These should be removed in separate garbage and ash carts; the former should be galvanized-iron carts, which are covered in order to prevent the effluvia which arises from the decomposing mass from becoming a nuisance; the ash carts are better and more easily disinfected if made of iron, and they should also be provided with covers so as to prevent the wind blowing the fine ashes and dust into the street, to the detriment of the respiratory passages as well as the clothing of pedestrians. In winter, when large quantities of coal are used, the ash carts should collect the ashes at least every third day; in summer once a week will suffice, though daily collections are necessary in tenement-house districts, where the inhabitants have no means for storage.

In order to prevent the accumulation of kitchen refuse in the house it is necessary that it should be removed daily, especially in summer time. Instead of being removed in carts, it may be collected in covered buckets or pails; the disadvantage of this method is that these receptacles will be less than half full at one house and overfilled at another. It also entails more trouble and expense to disinfect a number of pails than one cart.

Garbage may be disposed of by dumping on land or into a water course or the ocean, or it may be cremated. It is a common practice in American cities to dispose of all garbage by creating a midden heap at some dumping place; the organic matter, owing to the large quantity of ashes and the absence of what Dr. Poore has appropriately termed the "living earth," decomposes and there is that disgusting pollution of the atmosphere with which most inhabitants of large communities are familiar. If low ground is used for such dumping and is afterward employed as a site for building, it is almost impossible to prevent poisoning of the atmosphere of the building by the polluted soil. In villages or small communities where there are wells a public dumping ground is not unlikely to become a source of contamination to the well water, although this will not be the case if the garbage is composed only of ashes and is free from all organic matter.

Dumping garbage into a water course or carrying it by scows into the ocean has the disadvantage of polluting the water course with organic matter which will not be disposed of by fish, and filling up the bed of the stream, or of the tide conveying it back again to the shore. Here, again, the dumping of ashes alone would not be prejudicial to health, but regard must be had for the impracticability of getting all the inhabitants of a city to burn their kitchen refuse and general rubbish.

The practice of separating kitchen garbage and using it to feed cattle or pigs is feasible in the country, but in a large city the expense of its transportation to points where it will be consumed is heavy, and too often this garbage is unfit for food.

Another method of disposal of the kitchen garbage of a city is by one of the patented processes, in which the garbage is heated and dried by superheated steam for about six hours, losing over half its weight, and is then mixed with benzine or some similar liquid which will separate the fatty matter; by distillation the fat is separated from the benzine, which is used over again, and sold.

Cremation of refuse has been in use for a number of years, and is one of the best, if not the best, of the methods mentioned for the disposal of garbage. The garbage is burned in a number of furnaces, the moisture first being driven off by heating it in chambers near the furnaces; the heat from these destructors is used for boilers which may utilize the steam in various ways, such as the production of electric light. With the products of combustion, partly burned vapours and fine dust are likely to be carried off by the chimney, producing a nuisance; this may be prevented by passing all smoke, etc., from the furnaces through a second furnace at the foot of the chimney. The clinkers from the furnace are used for the foundation of roadways and the manufacture of artificial stone, while the fine ashes are used for making mortar. A careful estimate has shown that the cremation of garbage is more economical than any other method of disposal, excepting dumping.

In country places where animals are not kept that will dispose of the kitchen garbage Dr. G. V. Poore recommends that a piece of galvanized-wire netting three or four feet wide be used to inclose a circular space some three or four feet in diameter, the netting being fastened upright by means of a few wooden stakes. All kitchen and garden refuse which will decompose is thrown into this netting and a little earth is thrown upon the heap from time to time; there is no offensive odour from such a heap, because it is exposed to the air on all sides, and it slowly settles down. When one such heap is filled a second may be started, and after a full refuse heap has fermented for some time it should be sifted; the siftings are used for fertilization, and any residue is burned. The rule should be that refuse susceptible of decomposition should be covered

with earth, while all other refuse should be burned, as the ash contains large quantities of mineral substances which are useful for manure. Cinders are useless as manure, and these with broken glass and crockery can be used for drainage trenches or as the foundation of garden paths. Dr. Poore says that there is scarcely any form of domestic refuse that is not serviceable in the garden; bones and the shells of fish should be burned until converted to an ash that may be used for fertilizing purposes, while tin cans which held food products are hammered into a flat bulk and buried where they can not interfere with tillage; he considers that a scavenger's cart robs men of that which not enriches it but makes them poor indeed, and that it is a strain upon his conscience to pay taxes to support an institution which is not only useless, but which literally preaches thriftlessness to the unthinking poor.

Street Cleaning.

Street cleaning and the disposal of garbage exercise an important influence on public health, and ought in all cases to be performed by the local authorities and not by the individual householder. Over one fourth of the refuse of a city is composed of the sweepings of the streets.

Streets should be swept at night or in the early morning, after or before the traffic of the day, and before sweeping in dry weather they should be sprinkled so as to settle the dust and prevent its being blown about by the wind. In fact, during dry weather streets should be sprinkled morning and afternoon, independently of sweeping, in order to prevent the dust being blown into the respiratory passages and into houses. There are a number of excellent patterns of sprinkling carts, and their use should be more general.

Removal of Ice and Snow.

In Northern cities the removal of ice and snow is an expensive feature of street cleaning; if allowed to remain, traffic is interfered with, walking is an abomination, and the snow becomes mixed with all kinds of filth. The snow and ice are usually cleared from the pavement by the householder; in the streets it is best shovelled into long, high ridges, which leave a space between the snow and the gutter to convey the melted snow to the sewers, and the space between the ridges is free for the passage of vehicles. The ridges are shovelled into carts, and the snow thus removed as fast as possible, the work being begun in those parts of the city where traffic is heaviest and population densest.

CHAPTER X.

FOOD.

Definition.

Food is a general term used to designate the substances which, when taken into the body, yield the energy that maintains the functional activity of the organism or build the tissues requisite for growth. During adolescence growth is promoted by means of food which, in adult life, also maintains the weight of the body at a normal standard or increases the weight under certain conditions, while in all stages of life it is the function of food to supply the material necessary to produce animal heat and to yield the muscular and nervous power essential for the body's work.

Classification.

The nutritive ingredients or "nutrients" of foods are classified as inorganic, such as mineral salts and water, and organic; the latter are subdivided into nitrogenous, proteid or albuminous, and non-nitrogenous nutrients, such as fats, carbohydrates, and vegetable acids. The following scheme will show Richet's classification of foods:

A. Without carbon, inorganic.

B. With carbon, organic............	Non-nitrogenous.	Carbohydrates.
		Fats.
	Nitrogenous	Albuminoids.
		Non-albuminoids.

All animal bodies contain among their chemical elements carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, chlorine, fluorine, silica, potassium, sodium, calcium, magnesium, iron, and manganese; these occur in various combinations. Water forms about two thirds of the body weight. Albuminous or proteid substances constitute the greater portion of the solid and a part of the fluid tissues of the body, and by their oxidation certain nitrogenous substances are formed and excreted; the proteids are composed of carbon, hydrogen, nitrogen, oxygen, and sulphur, and some contain phosphorus. Fats, which constitute a portion of all animal bodies, are composed of carbon, hydrogen, and oxygen. As the elements which form the constituents of the body are derived from food, it is essential that the latter should contain all the elements that are found in the body, for there is no living matter without proteid, carbohydrate, fat, and certain mineral constituents.

Average Amount consumed Daily.

Charles Richet made an estimate, based on the population of Paris in 1890 and the amount of food stuffs consumed in that city in that year, that an average man weighing 145·5 pounds or an average woman weighing 125·25 pounds consumed daily:

Article.	Quantity, grains.	Article.	Quantity, grains.
Bread	8,024	Pastry and cakes	309
Beef	3,549	Rice and starches	154
Pork	617	Sugar	693
Poultry and game	617	Butter	462
Fish	617	*Liquids.*	
Eggs	541	Milk	1,928
Fruits	12,345	Wine	10,801
Fresh vegetables	6,944	Olive oil	185
Dried vegetables	463	Cider and beer	772
Potatoes	1,388	Alcoholics	386

The pastry and cakes should be included with the bread and rice, making a total of 8,478 grains. The meat, poultry, game, and fish amount to 5,400 grains of gross weight, and if allowance is made for bone, fat, feathers, and skin or shells, the quantity is reduced to 4,021 grains. So the weight of the fresh vegetables and fruits makes no allowance for the peelings, etc., which probably amount to half the weight. Oil and butter might be included as fats amounting to 648 grains.

Carbohydrates.

Of the non-nitrogenous nutrients, the *carbohydrates* are derived chiefly from vegetable foods. These occur in potatoes, wheat, corn, and other starchy foods. Sugar, glucose, sorghum, etc., and cellulose are carbohydrates; they are composed of carbon, hydrogen, and oxygen. The natural ferments of the saliva and the pancreatic juice convert starch into a sugar called maltose, which is converted into a sugar known as dextrose; a substance called invertin changes ordinary cane sugar into invert sugar, which is a mixture of two sugars—levulose and dextrose. The portal system conveys the sugar to the liver, and under the influence of the cells of the liver and other organs this sugar (dextrose) is converted into glycogen; the investigations of Pavy and others indicate that the latter substance when associated with nitrogenous matter is converted into proteid matter. Dr. Pavy holds that so closely is the nitrogenous portion of the food concerned in the assimilation of carbohydrate matter, when the former is deficient in quantity the carbohydrates do not become applied to the nourishment of the system in the same beneficial manner as when nitrogenous substances are present in proper proportion. That carbohydrates are important fat producers is shown by numerous exact experiments with animals; the intestine constitutes the main seat of preparation of carbohydrate matter for absorption and subsequent use in the system, and fatty matters are found flowing through the lacteals into the system, while according to some authorities their presence can be accounted for only on the hypothesis that the fat originated in the carbohydrate matter of the food.

Fat is a constituent in the dietary of most nations, either in the form

of meat, tallow, lard, milk or cream, butter, and vegetable oils. It differs from the carbohydrates—which also contain carbon, hydrogen, and oxygen—because there is not enough oxygen to combine with the hydrogen and form water in a molecule of fat.

Fats.

Proteids, or nitrogenous compounds, or *albuminoids* constitute a most important class of foods. They include the albumen or white of eggs, the casein or curd of milk, the myosin or basis of muscle, the fibrin of the blood, the gluten of wheat, the conglutin of peas and beans, and the globulins contained in the seeds of cereals and other classes of the vegetable kingdom.

Proteids.

The proteids include the group called *gelatinoids*, such as the ossein and gelatin of bones, the chondrin of cartilage, and the keratin of the hair, nails, horns, etc. The nitrogenous ingredients of foods and of the body are commonly grouped together under the designation "protein."

The *vegetable acids*—oxalic, tartaric, citric, acetic, malic, etc.—form salts in the body which are converted into carbonates that preserve the alkalinity of the fluids and tissues of the body.

Organic nitrogenous matter is an essential ingredient of food, and in the digestive tract the pepsin and hydrochloric acid of the gastric juice convert it into peptones, albumoses, and syntonin; and the trypsin of the pancreatic juice converts it into peptones, a part of which are converted into leucin and tyrosin. Therefore by gastric and intestinal digestion nitrogenous matters are converted into albumoses and peptones, which are transformed into the proteids of the blood; these are taken up by the cell elements to nourish the tissues of the body and form the essential basis of those structures which possess active or living properties. While the decomposition of these substances varies with the quantity taken in the food, it may be said, in general, that the amount of nitrogenous matter ingested must equal the quantity that is excreted if health is to be preserved.

Nutritive Functions of Food.

Some of the gelatinoids are useful as food stuffs; gelatin is easily digested and has a certain nutritive value that is best manifested when it is mixed with some other proteid, or nitrogenous substance, such as meat. Chondrin and keratin are vastly inferior to gelatin for food purposes.

The fats and carbohydrates are sources of energy and heat; they may be of animal or vegetable origin, the former being more digestible. The digestion of fats takes place in the small intestine by the action of the pancreatic and intestinal juices which separate it into very minute globules, such as exist in milk, and these are absorbed by the intestinal villi.

Carbohydrates have the advantage of being cheaper than nitrogenous foods, and reference has been made to the fact that they produce fatty

substances, but that the production is limited unless some nitrogenous substance is associated with them.

Water is an essential element of food not because it undergoes any change like other foods, but because its solvent properties are essential for the solution and absorption of aliment as well as the excretion of effete substances produced in the body.

Like water, saline substances are essential, not for the production of energy, but because they constitute important elements in certain fluids, tissues, and secretions of the body. Phosphate of lime is present in all the structural elements of the body, and, with the phosphates of calcium and magnesium, constitutes the greater portion of the solid parts of bone. Sodium chloride is important to keep the globulins of the blood in solution, and as a source of the hydrochloric acid in the gastric juice. Iron salts are essential for their influence in forming the hæmoglobin of the red blood-corpuscles.

Nutritive Value of Food Stuffs.

All vital processes are associated with two forms of force or energy—heat and motion. The first is manifested by the almost constant temperature of the normal human body, and the second by the beating of the heart, the respiratory and other muscular movements, and the activity of the cells of all the tissues of the body. These forms of energy are developed as food undergoes the processes of change, or metabolism, in the body, and in a healthy adult at labour have been estimated at one fifth cellular labour and four fifths heat. The unit of force, or kilogrammetre, is considered to be the amount of energy which is essential to raise one kilogramme (2·204 pounds avoirdupois) to the height of one metre (3·28 feet); and the unit of heat, called a calorie, or gramme-degree, is the amount of heat which is necessary to raise one gramme (15·43 grains) of water one degree centigrade (1·8° Fahr.); one thousand gramme-degrees are equivalent to four hundred and twenty-five kilogrammetres.

The amount of potential energy in food stuffs may be expressed by measurements of heat or of mechanical labour; these latter are determined by an apparatus called a calorimeter. Prof. Rubner calculated that

In one pound of protein	there	are	1,860	calories.
" " " " fat	"	"	4,220	"
" " " " carbohydrates	"	"	1,860	"

Rubner calculated that 100 parts of animal albumin equals 52 parts of fat, or 114 parts of starch, or 129 parts of dextrose; and that to produce the same amount of energy it would be necessary to take 100 parts of fat, 232 parts of starch, 234 parts of cane sugar, or 256 parts of dry dextrose. Prof. Frankland calculated that 0·55 pound of fatty matter would furnish the same amount of power as could be obtained from 1·3 pound of flour,

1·5 pound of sugar, 3·5 pounds of lean beef, and 5 pounds of potatoes; now these figures show that the potential energy of a food stuff simply indicates its nutritive value in a certain direction, but not that it is unimportant whether the energy is obtained from a proteid, a hydrocarbon, or a carbohydrate, for the 3·5 pounds of lean beef might be digested with more difficulty than the 0·55 pound of fatty matter, and with less difficulty than the 5 pounds of potatoes.

The graphic chart of the composition of food materials as they are bought in the market, including the edible and non-edible portions, given on the following page, is from Dr. W. O. Atwater's valuable monograph on *Foods and Diet.**

This table shows that animal foods contain the most water, and vegetable foods, excepting potatoes and turnips, the most nutrients. The fatter the meat the less the amount of water; very lean meat may be almost four fifths water, fat sirloin almost two fifths, and fat pork almost one tenth water. The flesh of fish contains more water than that of warm-blooded animals. It may also be noticed that while the vegetable foods are rich in carbohydrates, meats contain none, though the latter contain large quantities of protein and fats which are present in very small proportions in most vegetables, except beans and oat-meal.

Weight for weight, fats have almost 2·25 times the potential energy of either proteids or carbohydrates; and as water has no potential energy, food stuffs that have the most fat and the least water, such as butter and fat pork, have the highest fuel value. Lard, suet, and especially olive oil exceed butter in fuel value, while oleomargarine about equals it. The ribs and flanks are the fattest cuts of beef, the loin is the fattest cut of mutton or lamb, while lean cuts of pork contain as much fat as the fattest cuts of other meats. Prof. Atwater calls attention to the high fuel value of canned corned beef, which is cooked before canning, and, being free from bone and other refuse, contains a larger amount of protein and fats than an equal quantity of fresh beef. The table does not show the nutritive ingredients of chicken and turkey, which have less fat than some meats, contain a large amount of refuse, bone, etc., and furnish large quantities of protein. Fish that have dark meat are rich, those that have light meat are generally though not always poor, in fats. Attention is directed to the similarity in the proportions of the nutrients in oysters and in milk.

Cheese contains more proteids and fats and less water than milk, the first-mentioned constituents exceeding in quantity the proportions contained in most meats; a pound of cheese contains about twice as much

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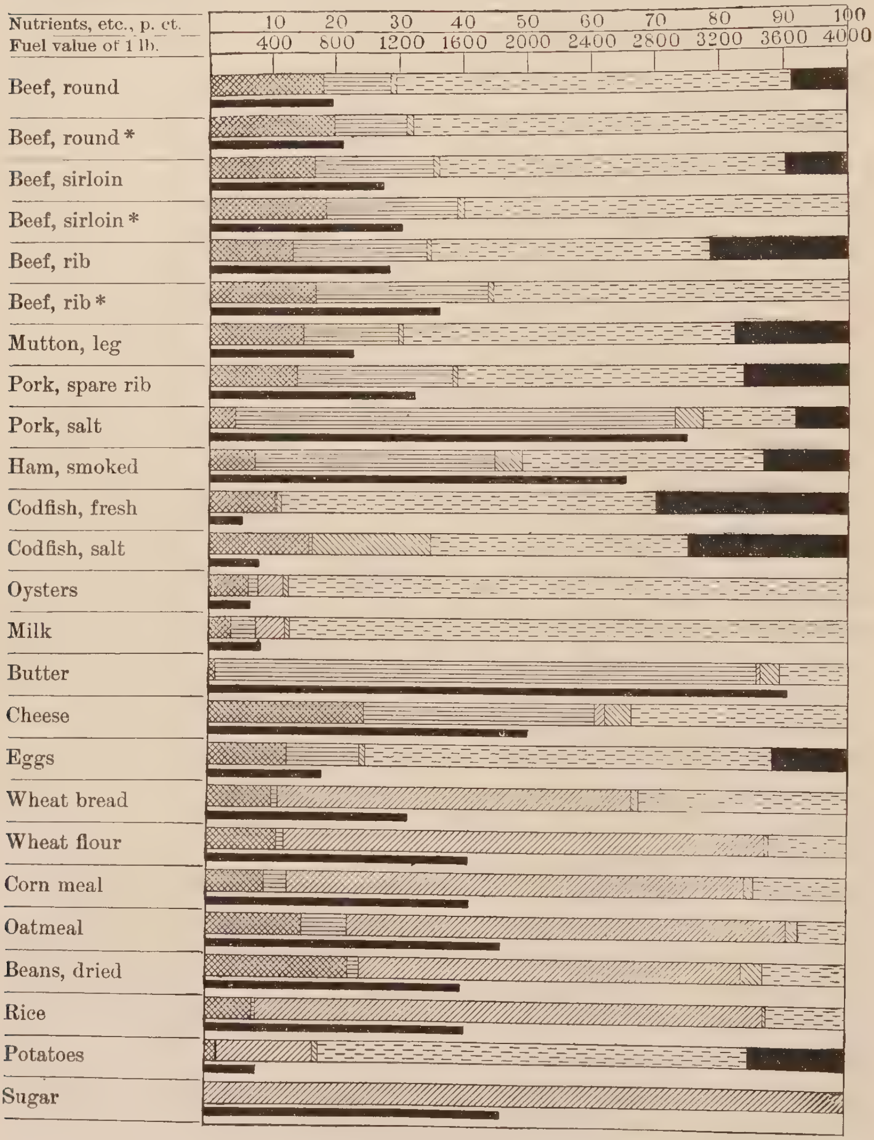
* The Yearbook of the U. S. Department of Agriculture for 1894. See also Bulletin 21 of the Office of Experiment Stations of the U. S. Department of Agriculture on Methods and Results of Investigations on the Chemistry and Economy of Foods.

COMPOSITION OF FOOD MATERIALS.

Nutritive ingredients, refuse, and fuel value.

Nutrients: Protein. Fats. Carbo-hydrates. Mineral matters.
Non-nutrients: Water. Refuse.
Fuel value: Calories.

Protein compounds—*e. g.*, lean of meat, white of egg, casein (curd) of milk, and gluten of wheat—make muscle, blood, bone, etc.
Fats—e. g., fat of meat, butter, and oil, *Carbohydrates—e. g.*, starch and sugar, } serve as fuel to yield heat and muscular power.



* Without bone.

of nutrients as a pound of good meat, but if eaten cooked, as in Welsh rarebit, the cheese is not easily digested and assimilated.

Vegetable foods differ principally in the quantity of water and protein, the former constituent being always greater in fresh vegetables, as in beets and turnips, in which it amounts to almost ninety per cent. Dry vegetable food stuffs, such as the different kinds of flour and meal, contain about seven eighths nutrients and one eighth water; the amount of protein is greater in oatmeal than in wheat flour.

Nutritive Value and Digestibility.

A calculation of the amount of carbon and nitrogen will not determine the nutritive value of a food, because the latter quantity depends not only upon the amount of nutrients it contains, but also upon the proportion of these nutrients that are digested and absorbed. The digestibility of food includes such different factors as the facility with which a particular food stuff is changed into substances utilized in the body, the time that is required for such processes, and the influence of different substances and conditions on digestion. As Prof. Atwater says, the effects upon health and comfort are so dependent upon the peculiarities of different individuals and are so difficult to measure that it is impossible to make hard-and-fast rules regarding the digestibility of food.

The quantity of food digested is obtained by weighing and analyzing the quantity of food consumed and the amount of excrement passed, and as the latter represents the amount of food undigested and unassimilated, the difference between the latter and the food consumed is the amount digested.

The proteids of meat, fish, eggs, milk, and cheese are more digestible than those of potatoes, peas, rice, and white and rye bread. As regards the relative digestibility of meat and fish, or white meat and dark, there is a difference of opinion. Raw beef is more digestible than smoked beef.

The investigations of physiologists have shown that the flesh of animals and fish remains in the stomach from two and a half to five hours; in order of digestibility, lamb is first, then beefsteak, lean meat, mutton, fish, veal, and pork. Much of the fat of animal food may fail of digestion, and Prof. Atwater considers that, as ordinarily eaten, five per cent. of the fat of meats, eggs, milk, butter, oleomargarine, and lard will be undigested. If cooking makes the meat tough it becomes more indigestible.

Such starchy foods as rice, barley, and tapioca remain in the stomach about two hours; beans, peas, and potatoes remain about two and a half hours; white bread remains three, and brown bread four hours. Vegetable food, consisting as it does of large quantities of carbohydrates, is digested more or less completely, even the cellulose being of use in the processes of digestion.

Diet and Dietaries.

To preserve health it is necessary to arrange a diet suited to the demands of the body; it must contain enough proteids, salts, and water to aid in forming and repairing tissue, and enough carbohydrates and fats to keep the body warm, for if the food is insufficient in quantity or quality the body will be improperly nourished and the health impaired in consequence.

Individuals differ in their ability to digest food, and modifications in health may make a difference in the ability of the same individual to digest food. Some persons can not eat certain fruits, others avoid certain meats, others milk or eggs, etc.

If too much food is taken at a meal the stomach is distended by the bulk and there is imperfect digestion. Part of the meat is not converted into peptones, the carbohydrates and fats are split up by the action of bacteria into butyric and other fatty acids, and the foods are not absorbed from the digestive tract. The amount of food required for different people varies with the occupation, age, sex, and idiosyncrasies of the individual as well as with the climate.

During the first six months of life the rapid growth of the infant necessitates food which will furnish the material necessary for that growth as well as for the maintenance of the nitrogen equilibrium of the body. The following table, prepared by König, shows the minimum amount of nutrients required daily at different ages:

Period of Life.	Weight in ounces.		
	Proteid.	Fat.	Carbohydrates.
Child up to one year and a half........	0·64 to 1·15	0·96 to 1·44	1·92 to 2·88
Child from six to fifteen years.........	2·15 to 2·57	1·19 to 1·60	8·03 to 12·86
Man at moderate work.	3·70	1·80	16·5
Woman at moderate work.............	2·95	1·41	12·86
Old man............................	3·21	2·18	11·24
Old woman..........................	2·57	1·60	8·35

The diet of children varies with the rapidity of growth, the carbohydrates and fats being proportional to the carbonic acid excreted.

Physiological experiments and investigations have furnished data that permit the calculation of diet for an individual at work or at rest.

	Moderate work.				Active work.				Severe work.	
	Playfair.	Moleschott.	Pettenkofer and Voit.	Atwater.	Playfair.	Moleschott.	Voit.	Atwater.	Smith and Playfair.	Atwater.
	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.	Oz.
Proteids..................	3·52	4·59	4·83	4·48	5·64	4·94	5·12	5·28	6·50	6·24
Fats.....................	1·76	2·96	4·12	4·48	2·56	3·17	3·52	5·28	2·85	8·80
Carbohydrates...........	14·08	14·26	12·40	15·84	20·00	15·31	15·84	17·60	20·10	22·88
Fuel value, calories......	3,140	3,160	3,055	3,520	3,630	.....	3,370	4,060	......	5.700

The foregoing table shows the difference of diet necessary for different characters of work, and as people who do not do muscular exercise require less food than those who work, the diet for an individual at rest should be less than that of one doing moderate work. The greater the work done the larger the amount of food necessary.

Prof. Atwater has compiled a valuable table, published in his monograph on *Foods: Nutritive Value and Cost* (Farmer's Bulletin No. 23, U. S. Department of Agriculture), which shows how the actual dietaries of people of different classes in different parts of the world compare with the standard dietaries above referred to.

American and European Dietaries and Dietary Standards.

[Quantities per man per day.]

Dietaries.	Nutrients. Protein.	Fats.	Carbohydrates.	Fuel value.	Nutritive ratio.*
American (Massachusetts and Connecticut).	Pounds.	Pounds.	Pounds.	Calories.	1:
Family of carpenter in Middletown, Conn.	0·25	0·28	0·76	3,055	5·5
Family of glass blowers in East Cambridge, Mass.	0·23	0·29	1·06	3,590	8·2
Boarding house, Lowell, Mass.; boarders, operatives in cotton mills	0·29	0·44	1·21	4,650	7·6
Boarding house, Middletown, Conn.; well-paid machinists, etc., at moderate work — Food purchased	0·28	0·41	0·94	4,010	6·8
Boarding house, Middletown, Conn.; well-paid machinists, etc., at moderate work — Food eaten	0·23	0·34	0·84	3,490	7·3
Blacksmiths, Lowell, at hard work	0·44	0·67	1·75	6,905	7·4
Brickmakers, Massachusetts; 237 persons at very severe work	0·40	0·81	2·54	8,850	11·0
Mechanics, etc., in Massachusetts and Connecticut; average of four dietaries of mechanics at severe work	0·48	0·65	1·65	6,705	6·6
Average of twenty dietaries of wage workers in Massachusetts and Connecticut	0·34	0·50	1·38	5,275	7·5
Average of five dietaries of professional men and college students in Middletown, Conn. — Food purchased	0·30	0·36	1·12	4,140	6·6
Average of five dietaries of professional men and college students in Middletown, Conn. — Food eaten	0·27	0·34	1·08	3,925	6·6

* The nutritive ratio is the ratio of the protein to the sum of all the other nutritive ingredients. The fuel value of the fat is two and a quarter times that of the protein and carbohydrates. In calculating the nutritive ratio the quantity of fats is multiplied by two and one fourth. This product is added to the weight of the carbohydrates. The sum divided by the weight of the protein gives the nutritive ratio. Materials with large amounts of fats or carbohydrates and little protein, like fat meats or potatoes, have a "wide" nutritive ratio. Those with a large amount of protein as compared with the carbohydrates and fats, like lean meat, codfish, and beans, have a "narrow" nutritive ratio. In other words, the materials rich in tissue-forming substances have a narrow, and those with a large preponderance of fuel materials have a wide, nutritive ratio. This is an important matter in the adjusting of food to the demands of the body.

A well-balanced diet is one which has the right ratio of protein to the fats and carbohydrates. A relative excess of the tissue formers makes the ratio narrow, while an excess of the fuel ingredients makes an overwide ratio in the diet. Either of these errors is disadvantageous. Our food materials and our diet are apt to have too wide a nutritive ratio. In other words, we consume on the whole relatively too little protein and too much of the carbohydrates and fats.

Dietaries.	Nutrients.			Fuel value.	Nutritive ratio.
	Protein.	Fats.	Carbohydrates.		
European (English, German, Danish, and Swedish).	Pounds.	Pounds.	Pounds.	Calories.	1:
Well-fed tailors, England, Playfair	0·29	0·09	1·16	3,055	4·7
Hard-worked weavers, England, Playfair	0·34	0·09	1·37	3,570	4·8
Blacksmiths at active labour, England, Playfair	0·39	0·16	1·47	4,115	4·7
Mechanic, Munich, sixty years old, in comfortable circumstances, light work, Forster	0·26	0·15	0·76	2,525	4·3
Well-paid mechanics, Munich, Voit	0·34	0·12	1·06	3,085	4·0
Carpenters, coopers, locksmiths, Bavaria; average of eleven dietaries, Voit	0·27	0·08	1·28	3,150	5·3
Miners at severe work, Prussia, Steinheil	0·30	0·25	1·40	4,195	6·7
Brickmakers (Italians), Munich; diet mainly maize meal and cheese, severe work, Ranke	0·37	0·26	1·49	4,540	5·6
German army ration, peace footing	0·25	0·09	1·06	2,800	5·0
German army ordinary ration, war footing	0·30	0·13	1·08	3,095	4·6
German army extraordinary ration, in war	0·42	0·10	1·49	3,985	4·1
University professor, Munich; very little exercise, Ranke	0·22	0·22	0·53	2,325	4·7
Lawyer, Munich, Forster	0·18	0·28	0·49	2,400	6·3
Physician, Munich, Forster	0·28	0·20	0·80	2,830	4·4
Physician, Copenhagen, Jurgensen	0·30	0·31	0·53	2,835	4·1
Average of seven dietaries of professional men and students, Germany, Denmark, and Sweden	0·25	0·22	0·63	2,670	4·7
Dietary Standards.					
Adult in full health, Playfair	0·26	0·11	1·17	3,140	5·5
Active labourers, Playfair	0·34	0·16	1·25	3,630	4·7
Man at moderate work, Moleschott	0·29	0·09	1·21	3,160	4·9
Man at moderate work, Voit	0·26	0·12	1·10	3,055	5·3
Man at hard work, Voit	0·32	0·22	0·99	3,370	4·7
Man with little physical exercise, Atwater	0·20	0·20	0·66	2,450	5·5
Man with light muscular work, Atwater	0·22	0·22	0·77	2,800	5·7
Man with moderate muscular work, Atwater	0·28	0·28	0·99	3,520	5·8
Man with active muscular work, Atwater	0·33	0·33	1·10	4,060	5·6
Man with hard muscular work, Atwater	0·39	0·55	1·43	5,700	6·9

On the basis of the foregoing standard of dietaries a man doing moderately hard muscular work should eat thirteen ounces of round steak, which contains 0·14 pound of proteids, equal to 695 calories; three ounces of butter, which equal 680 calories; six ounces of potatoes, which contain 0·02 pound of proteids, equal to 320 calories; and twenty-two ounces of wheat bread, which contain 0·12 pound of proteids, equal to 1,760 calories; thus making the total proteids 0·28 pound, equal to 3,455 calories. The proportion between the proteids and the non-nitrogenous organic food stuff in a diet should average from 1 to 3·5 or 4·5, while the proportion of fat to carbohydrates should not be less than 1 to 9.

In arranging a dietary due attention must be paid to the daily quantity of food, which must not be indigestible on account of bulk, proportion of cellulose, acidity, or bad cooking. There must be a variety in the food supply, and the flavouring and seasoning should receive careful attention.

A great deal of information may be obtained from the table of diet-

aries arranged by Prof. Atwater, which indicate the different combinations and cost of foods for an average man doing moderately hard muscular work:

Prices used in estimating Cost of Daily Dietaries.

Articles.	Price per pound, cents.	Articles.	Price per pound, cents.
Beef:		Fish (continued):	
Neck	7	Dry salt cod	7
Chuck	10	Salt mackerel	12
Shoulder	12	Canned salmon	15
Sirloin	20	Lobster	12
Rump	16	Eggs, 24 cents per dozen	14
Round	14	Milk, 7 cents per quart	3½
Liver	10	Butter	30
Dried beef	25	Cheese	16
Mutton:		Potatoes, white	1¼
Shoulder	12	Sweet potatoes	2
Leg	18	Turnips	2
Loin	20	Sugar	5
Pork:		Beans	5
Loin	16	Corn meal	2½
Ham	16	Oatmeal	5
Salt pork	12	Wheat flour	2½
Sausage	12	Graham flour	3
Fish:		Wheat bread	4
Mackerel	12	Rice	7
Whole cod	8	Canned corn	16

Daily Dietaries. Food Materials furnishing approximately the 0·28 Pound of Protein and 3,500 Calories of Energy of the Standard for Daily Dietary of a Man at Moderate Muscular Work. Cost estimated from Prices given in Preceding Table.

Food Materials.	Amount.	Cost.	Nutrients.				Fuel value.
			Total.	Protein.	Fats.	Carbo-hydrates.	
I.	Ounces.	Cents.	Pounds.	Pounds.	Pounds.	Pounds.	Calories.
Beef, round steak	13	11·40	0·26	0·14	0·12	....	695
Butter	3	5·65	0·16	....	0·16	....	680
Potatoes	6	1·25	0·17	0·02	....	0·15	320
Bread	22	5·50	0·89	0·12	0·02	0·75	1,760
	44	23·80	1·48	0·28	0·30	0·90	3,455
II.							
Pork, salt	4	3·00	0·21	....	0·21	....	880
Butter	2	3·75	0·11	....	0·11	....	450
Beans	16	5·00	0·84	0·23	0·02	0·59	1,615
Bread	8	2·00	0·33	0·04	0·01	0·28	640
	30	13·75	1·49	0·27	0·35	0·87	3,585
III.							
Beef, liver	9	5·65	0·17	0·12	0·03	0·02	375
Butter	3	5·65	0·16	....	0·16	....	780
Milk, ½ pint	8	1·75	0·06	0·02	0·02	0·02	165
Corn meal	12	1·85	0·63	0·07	0·03	0·53	1,230
Bread	12	3·00	0·50	0·07	0·01	0·42	965
	44	17·90	1·52	0·28	0·25	0·99	3,515

Food Materials.	Amount.	Cost.	Nutrients. Total.	Protein.	Fats.	Carbo-hydrates.	Fuel value.
	Ounces.	Cents.	Pounds.	Pounds.	Pounds.	Pounds.	Calories.
IV.							
Beef, sirloin steak	12	15·00	0·25	0·12	0·13	....	725
Butter	3	5·65	0·16	....	0·16	....	680
Milk, 1¾ pint	28	6·15	0·22	0·06	0·08	0·08	570
Potatoes	12	0·95	0·12	0·01	....	0·11	240
Flour	12	1·85	0·65	0·08	0·01	0·56	1,235
	67	29·60	1·40	0·27	0·38	0·75	3,450
V.							
Ham	12	12·00	0·37	0·11	0·26	....	1,300
Pork, salt	½	0·35	0·03	....	0·03	....	110
Butter	1	1·90	0·05	....	0·05	....	225
Potatoes	8	0·65	0·09	0·01	....	0·08	160
Beans	5	1·55	0·27	0·07	0·01	0·19	505
Flour	12	1·85	0·65	0·08	0·01	0·56	1,235
	38½	18·30	1·46	0·27	0·36	0·83	3,535
VI.							
Beef, neck	10	4·40	0·19	0·10	0·09	....	550
Butter	1	1·90	0·05	....	0·05	....	225
Milk, 1 pint	16	3·50	0·13	0·04	0·04	0·05	325
Potatoes	16	1·25	0·17	0·02	....	0·15	320
Oatmeal	4	1·25	0·23	0·04	0·02	0 17	460
Bread	16	4·00	0·67	0·09	0·02	0·56	1,280
Sugar	3	0·95	0·19	....	....	0·19	345
	66	17·25	1·63	0·29	0·22	1·12	3,505
VII.							
Beef, shoulder	8	6·00	0·16	0·09	0·07	....	450
Salmon, canned	4	3·75	0·10	0·05	0·05	....	245
Butter	2½	4·70	0·13	....	0·13	....	565
Milk, 1½ pint	24	5·25	0·18	0·05	0·06	0·07	485
Potatoes	8	0·65	0·09	0·01	....	0·08	160
Oatmeal	2	0·65	0·11	0·02	0·01	0·08	230
Flour	10	1·55	0·55	0·07	0·01	0·47	1,030
Sugar	3	0·95	0·19	....	....	0·19	345
	61½	23·50	1·51	0·29	0·33	0·89	3,510
VIII.							
Beef, chuck	10	6·25	0·22	0·09	0·13	....	800
Ham	6	6·00	0·19	0·06	0·13	....	650
Two eggs	3	4·00	0·05	0·03	0·02	....	135
Butter	2	3·75	0·11	....	0·11	....	450
Milk, 1 pint	16	3·50	0·13	0·04	0·04	0·05	325
Potatoes	12	0·95	0·12	0·01	....	0·11	240
Flour	8	1·25	0·44	0·05	0·01	0·38	825
Sugar	1	0·30	0·06	....	....	0·06	115
	58	26·0	1·32	0·28	0·44	0·60	3,540
IX.							
Beef, sirloin steak	8	10·00	0·17	0·08	0·09	....	485
Mutton chops	5	6·25	0·14	0·04	0·10	....	465
Butter	2	3·75	0·11	....	0·11	....	450
Milk, 1½ pint	24	5·25	0·18	0·05	0·06	0·07	485
Potatoes	8	0·65	0·09	0·01	....	0·08	160
Oatmeal	3	0·95	0·17	0·03	0·01	0·13	345
Bread	12	3·00	0·50	0·07	0·01	0·42	965
Sugar	2	0·65	0·12	....	....	0·12	230
	64	30·50	1·48	0·28	0·38	0·82	3,585

Food Materials.	Amount.	Cost.	Nutrients. Total.	Protein.	Fats.	Carbo-hydrates.	Fuel value.
	Ounces.	Cents.	Pounds.	Pounds.	Pounds.	Pounds.	Calories.
X.							
Beef, neck	12	5·25	0·22	0·12	0·10	....	660
Lobster	8	6·00	0·03	0·03	....	....	65
Butter	3	5·65	0·16	....	0·16	....	680
Milk, 1 pint	16	3·50	0·12	0·03	0·04	0·05	325
Potatoes	8	0·65	0·09	0·01	....	0·08	160
Oatmeal	2	0·65	0·12	0·02	0·01	0·09	230
Bread	12	3·00	0·50	0·07	0·01	0·42	960
Sugar	4	1·25	0·25	....	....	0·25	460
	65	25·95	1·49	0·28	0·32	0·89	3,540
XI.							
Beef, dried	3	4·70	0·06	0·05	0·01	....	140
Mutton, leg	10	11·25	0·19	0·09	0·10	....	580
One egg	1½	2·00	0·02	0·01	0·01	....	70
Butter	3	5·65	0·16	....	0·16	....	680
Milk, ¾ pint	12	2·65	0·09	0·02	0·03	0·04	245
Potatoes	8	0·65	0·09	0·01	....	0·08	160
Oatmeal	3	0·95	0·17	0·03	0·01	0 13	345
Bread	10	2·50	0·42	0·06	0·01	0·35	800
Sugar	4	1·25	0·25	....	....	0·25	460
	54½	31·60	1·45	0·27	0·33	0·85	3,480
XII.							
Beef, round steak	8	7·00	0·16	0·09	0·07	....	425
Cod, dried	2	0·90	0·03	0·03	....	....	40
One egg	1½	2·00	0·02	0·01	0·01	....	70
Butter	3	5·65	0·16	....	0·16	....	680
Milk, 1¼ pint	20	4·40	0·15	0·04	0·05	0·06	405
Potatoes	8	0·65	0·09	0·01	....	0·08	160
Oatmeal	2	0·65	0·12	0·02	0·01	0·09	230
Flour	10	1·55	0·55	0·07	0·01	0·47	1,030
Sugar	4	1·25	0·25	....	....	0·25	460
	58½	24·05	1·53	0·27	0·31	0·95	3,500
XIII.							
Sausage	4	3·00	0·14	0·03	0·11	....	510
Cod, whole	14	7·00	0·07	0·07	....	....	140
Butter	2	3·75	0·11	....	0·11	....	450
Milk, 1 pint	16	3·50	0·13	0·04	0·04	0·05	325
Beans	5	1·55	0·26	0·07	0·01	0·18	505
Rice	2	0·90	0·11	0·01	....	0·10	205
Sweet potatoes	16	2·00	0·24	0·01	....	0·23	420
Bread	8	2 00	0·33	0·04	0·01	0·28	640
Sugar	3	0·95	0·19	....	....	0·19	345
	70	24·65	1·58	0·27	0·28	1·03	3,540
XIV.							
Beef, rump	6	6·00	0·17	0·05	0·12	....	590
Mackerel	12	9·00	0·10	0·07	0·03	....	280
Butter	2	3·75	0·11	....	0·11	....	450
Cheese	1	1·00	0·04	0·02	0·02	....	130
Milk, 1 pint	16	3·50	0·13	0·04	0·04	0·05	325
Potatoes	8	0·65	0·09	0·01	....	0·08	160
Oatmeal	1	0·30	0·05	0·01	....	0·04	115
Flour (wheat)	8	1·25	0·44	0·05	0·01	0·38	825
Flour (Graham)	4	0·75	0·21	0·03	....	0·18	405
Sugar	2	0·65	0·12	....	....	0·12	230
	60	26·85	1·46	0·28	0·33	0·85	3,510

Food Materials.	Amount.	Cost.	Nutrients.				Fuel value.
			Total.	Protein.	Fats.	Carbo-hydrates.	
XV.	Ounces.	Cents.	Pounds.	Pounds.	Pounds.	Pounds.	Calories.
Beef, shoulder	9	6·75	0·18	0·10	0·08	....	515
Ham	6	6·00	0·19	0·06	0·13	....	655
One egg	1½	2·00	0·02	0·01	0·01	....	70
Butter	1½	2·80	0·08	....	0·08	....	340
Milk, ½ pint	8	1·75	0·06	0·02	0·02	0·02	165
Potatoes (white)	8	0·65	0·09	0·01	....	0·08	160
Sweet potatoes	8	1·00	0·12	0·01	....	0·11	210
Corn meal	8	1·25	0·42	0·05	0·02	0·35	825
Bread	4	1·00	0·16	0·02	....	0·14	320
Sugar	2	0·65	0·12	....	....	0·12	230
	56	23·85	1·44	0·28	0·34	0·82	3,490
XVI.							
Beef, chuck	8	5·00	0·18	0·08	0·10	....	560
Mackerel, salt	4	3·00	0·08	0·04	0·04	....	230
Two eggs	3	4·00	0·05	0·03	0·02	....	135
Butter	2½	4·70	0·13	....	0·13	....	565
Cheese	1	1·00	0·04	0·02	0·02	....	130
Milk, 1 pint	16	3·50	0·13	0·04	0·04	0·05	325
Potatoes	8	0·65	0·09	0·01	....	0·08	160
Rice	2	0·90	0·11	0·01	....	0·10	205
Bread	9	2·25	0·38	0·05	0·01	0·32	720
Sugar	1½	0·45	0·09	....	....	0·09	175
	55	25·45	1·28	0·28	0·36	0·64	3,205
XVII.							
Ham	8	8·00	0·24	0·07	0·17	....	870
Cod, dried	4	1·75	0·02	0·02	....	....	50
Three eggs	4½	6·00	0·07	0·04	0·03	....	200
Butter	1½	2·80	0·08	....	0·08	...	340
Cheese	1	1·00	0·04	0·02	0·02	....	130
Milk, 1 pint	16	3·50	0·13	0·04	0·04	0·05	325
Potatoes (white)	6	0·50	0·07	0·01	....	0·06	120
Sweet potatoes	8	1·00	0·12	0·01	....	0·11	210
Corn meal	8	2·50	0·42	0·05	0·02	0·35	825
Bread	4	1·00	0·16	0·02	....	0·14	320
Sugar	2	0·65	0·12	....	....	0·12	230
	63	28·70	1·47	0·28	0·36	0·83	3,620
XVIII.							
Pork chops, loin	8	8·00	0·20	0·07	0·13	....	665
Liver	8	5·00	0·15	0·10	0·03	0·02	330
One egg	1½	2·00	0·02	0·01	0·01	....	70
Butter	3	5·65	0·16	....	0·16	....	675
Milk, ½ pint	8	1·75	0·06	0·02	0·02	0·02	165
Potatoes	12	0·95	0·12	0·01	....	0·11	240
Turnips	4	0·50	0·02	....	....	0·02	35
Corn, canned	4	4·00	0·07	0·01	....	0·06	130
Oatmeal	1	0·30	0·06	0·01	0·01	0·04	115
Rice	1	0·45	0·05	....	....	0·05	100
Flour (wheat)	4	0·65	0·22	0·03	....	0·19	410
Flour (Graham)	2	0·40	0·11	0·02	....	0·09	205
Sugar	3	0·95	0·19	....	....	0·19	345
	59½	30·60	1·43	0·28	0·36	0·79	3,485

Important as the question of diet may be in the case of a healthy population, it is of much greater import in regard to the population of charitable, educational, and penal institutions, of hospitals, and of soldiers and sailors. The consideration of the diet of the sick is omitted here, as that matter is essentially a part of the treatment, while the diet of institutions does not come within the scope of this work.

Pecuniary Value of Food.

As the cost of food is the heaviest item in the living expenses of working people, who have to arrange their diet according to their wages, it is a matter of great importance to indicate how the most nutritious food may be obtained at the lowest price. In the United States, Great Britain, and Germany more than fifty per cent. of the income of a family is spent for food, which is often deficient in proteids and fats and excessive in carbohydrates. In most of the towns of the United States the cost of foods is greater than in the country, though the cost varies in different sections. The cheapest food has been defined as that which supplies the most nutriment for the least money, but the most economical food is that which is the cheapest and at the same time best adapted to the wants of the eater; and Prof. Atwater goes on to say that those who economize in the purchase and use of food, and who carefully consult the prices, have in general very vague ideas about the relation between the value of food for nourishment and its cost. He calls attention to the fact that from one dollar to two dollars a pound may be paid for the protein of animal food that could be obtained in other equally wholesome and nutritious forms for from fifteen to fifty cents per pound; and he refers to the fact that the cheapness or dearness of different food stuffs is often judged by the prices per pound, quart, or bushel, without regard to the amounts or kinds of actual nutrients which they contain. The graphic chart given on the following page is taken from Prof. Atwater's monograph on *Food and Diet* and gives an estimate of the amount of nutrients that could be purchased for ten cents.

The Preparation of Food.

All articles of food should be prepared before eating, and most food stuffs require cooking. Fruits and vegetables must be washed and peeled when eaten raw, the grain of wheat separated from the husk and ground, and bone, gristle, and superfluous fat removed from meat.

Good cooking will increase the digestibility of food, enhance its palatability, and destroy micro-organisms that are likely to be attached to it. Animal food is digested raw as well as cooked, but it is more palatable and more easily masticated when cooked. The essential object in cooking meat is to firmly coagulate the superficial layer of albumin in order to retain the flavouring and other constituents which have so great a nutritive value; and after coagulating the external portion, to continue the

PECUNIARY ECONOMY OF FOOD.

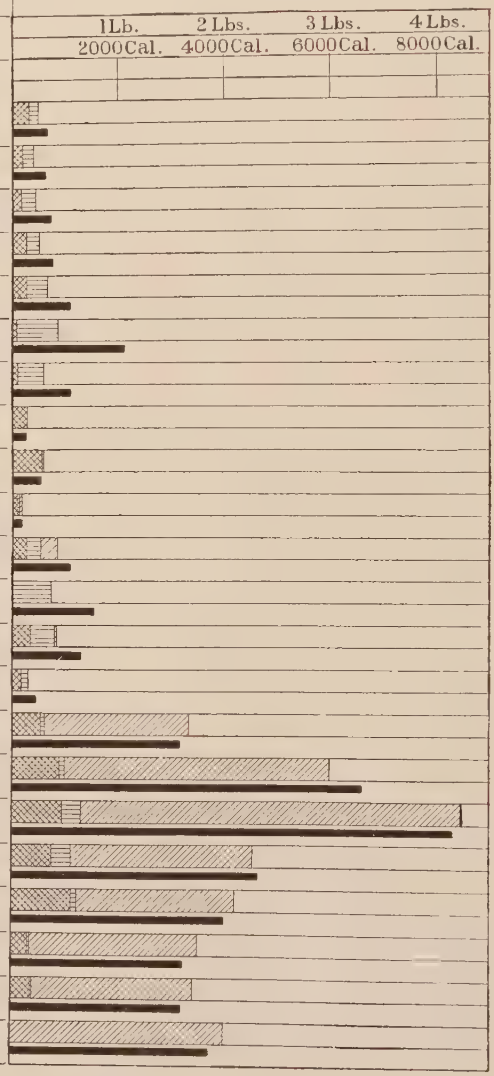
Amounts of actually nutritive ingredients obtained in different food materials for 10 cents.

Protein. Fats. Carbohydrates. Fuel value.

Protein compounds—*e. g.*, lean of meat, white of egg, casein (curd) of milk, and gluten of wheat—make muscle, blood, bone, etc.

Fats—*e. g.*, fat of meat, butter, and oil, } serve as fuel to yield heat and muscular power.
Carbohydrates—*e. g.*, starch and sugar, }

	Price per pound.	Ten cents will buy—	Pounds of nutrients and calories of fuel value in 10 cents' worth.
	Cents.	*Lbs.*	
Beef, round	12	0·83	
Beef, sirloin	18	0·55	
Beef, rib	16	0·63	
Mutton, leg	12	0·83	
Pork, spare rib	12	0·83	
Pork, salt, fat	14	0·71	
Ham, smoked	16	0·63	
Codfish, fresh	8	1·25	
Codfish, salt	6	1·67	
Oysters, 40 cents quart	20	0·50	
Milk, 6 cents quart	3	3·33	
Butter	24	0·42	
Cheese	16	0·63	
Eggs, 25 cents dozen	16⅔	0·60	
Wheat bread	4	2·50	
Wheat flour	2½	4·00	
Corn meal	2	5·00	
Oatmeal	4	2·50	
Beans, white, dried	4	2·50	
Rice	5	2·00	
Potatoes, 60 cents bushel	1	10·00	
Sugar	5	2·00	



process at a lower temperature in order that the meat may be cooked throughout. In boiling, the meat should be put in boiling water for from five to ten minutes so that the piece will be enveloped by a coating of firmly coagulated albumin; the kettle is then placed on a part of the stove where the water will retain a temperature of 180° Fahr., three quarters of an hour being allowed for each pound of meat, and a small quantity of salt added to the water in order to hasten the coagulation of the albumin and increase the density of the water so as to lessen the oozing out of the meat juices.

Stewing has for its object the partial extraction of the meat juices by the water, the moderate coagulation of the albumin, and the softening of the gelatin and fibrin; so meat should be stewed in water at a temperature between 135° and 160° Fahr., which is best attained by the use of a double boiler, the meat being left in the water for the same time as in boiling.

In roasting, the meat should be exposed to a hot fire and turned on the spit until its surface is brown, then moved away so as to avoid burning and turned constantly, twenty minutes being allowed for each pound of beef. It is customary in the United States to bake instead of roast meats; the piece is put in a baking pan, placed in a hot oven, and basted and turned every ten minutes or so lest it should burn.

Vegetables should be boiled in a small quantity of water to which a little fat and salt are added to prevent the loss of the vegetable salts; the globulins and albumins are coagulated by cooking, as is the case with meat, while the starch grain swells and bursts its covering of cellulose.

An excess of food is likely to result in indigestion; an excess of proteid food may cause disorders of the liver and the muscles; an excess of fats and starches is likely to produce dyspepsia and corpulence; and an excess of water increases the oxidation of the proteids.

Quality and Quantity of Food.

An inadequate supply of food results in general weakness, lessened resistance of the body, and increased risk of acquiring disease. An insufficient supply of proteids causes increased oxidation of the body proteids in order to maintain the equilibrium of nitrogenous matter, and there is loss of weight; an insufficient supply of fats and carbohydrates necessitates an increased supply of proteids, or otherwise there will be a consumption of the proteids of the body.

As a rule, persons eat too much and the diet is one-sided, there being too little proteid and too much fat and carbohydrate food in the shape of sugar, starch, and fat meats. Too little regard is paid to the quantity and quality of food demanded by different habits of life. The diet tables that have been given show that the most nutritious and wholesome dietary for a person doing a moderate amount of muscular work is one in

which there is a mixed diet consisting of a large proportion of vegetables and cereals and a smaller quantity of milk, fish, eggs, and meat. But for an individual leading a sedentary life and engaged in mental work, the best dietary will include a generous supply of vegetables and cereals and a small quantity of fish or flesh. The fish is recommended not because it contains any nutriment especially adapted to replenish the waste of the brain cells, but only because it is less likely than meat to overload the digestive system.

Noxious Foods.

Food may be noxious or unfit for use because, if meat, it is taken from diseased or immature animals or has undergone putrefactive changes; or, if vegetable, because it has decomposed or is unripe; or, if manufactured, because it is adulterated or because the processes of manufacture lessen its nutritive properties.

In most places there is a State or local law which authorizes sanitary inspectors to seize and destroy meat which is diseased, unsound, or otherwise unfit for food, when it is exposed for sale. Good meat is firm but elastic to the touch, and does not pit or crackle when pressed; its colour is uniform, bright, and marbled with fat. The flesh of mutton and pigs is paler than that of beef or calves. The inspection of all cattle that are to be killed for food should be a duty of the State, because expert knowledge is sometimes requisite to determine the existence of disease. Many animals are infected with parasites, some of which apparently exercise no deleterious effect on their host, and others, like the *Trichina spiralis*, may kill its host and infect any person who eats the flesh it infests. There is no doubt that the great prevalence of tuberculosis is due in part to the use of the meat products from tuberculous animals for food. The flesh of animals that have died of foot-and-mouth disease, pleuro-pneumonia, anthrax, swine fever, and the like, is apt to contain toxins that have been produced by the disease, if not the micro-organisms originating the malady.

Adulteration may produce food that is injurious or non-injurious to health, and investigation has shown that it is generally practised. Prof. Sharpless has included under the head of injurious or deleterious adulteration the use of copper in pickles, of red lead in Cayenne pepper, of arsenical colours in candy, and of water and other substances in milk. Non-injurious or fraudulent adulterations include the addition of chicory and other substances to coffee, of cotton-seed to olive oil, of flour and turmeric to ground mustard, of glucose to cane sirup, of oleomargarine to butter, etc. Any extended remarks upon the characteristics of adulteration are beyond the scope of this article, as their detection requires the use of special instruments and a knowledge of the details of microscopical and chemical investigation.

CHAPTER XI.

CLOTHING.

The essential purpose of clothing is to aid in maintaining the animal heat of the body, to afford protection against cold and heat, wind and rain, and, by varying the composition and quantity of clothing, to enable man to live in any climate. Besides this, clothing serves for decency and adornment.

Materials Employed.

The materials employed for clothing are derived from the animal and vegetable kingdoms; from the first are obtained furs, skins, leather, wool, silk, and feathers; from the second, linen, cotton, hemp, jute, and other substances. Besides these substances, metals, glass, and mineral dyes are used as accessories for clothing.

Furs have been used for clothing by the inhabitants of cold climates from time immemorial, and not only afford excellent protection against cold and wind, but also prevent the radiation of heat from the body. Skins of animals from which the hair has been removed are also of advantage to prevent the loss of heat, and when made tough by tanning or other process the skin, called leather, is used for shoes, leggings, caps, and other articles of clothing.

Wool is the hair of the sheep, alpaca, camel, Cashmere goat, and other animals; it is manufactured into cloth, yarn, flannel, etc. It is more porous and has a greater capacity for absorbing water than vegetable fabrics; it may feel warm and dry when it contains an amount of water that would make cotton or linen feel wet and cold, because, while it absorbs moisture freely, it parts with it slowly, and thus prevents chilling of the surface with lowering of the temperature due to evaporation. It is a non-conductor, and prevents the dissipation of the bodily heat. In consequence of its capacity for absorbing water it takes up perspiration. Woollen under-garments should be frequently washed, but unless washed in tepid water with a soap which contains no soda they become hard and the fibres shrink. Improved processes of manufacture have produced the so called natural wools, which cause less irritation when worn next to the skin than does the ordinary woollen or flannel underclothing.

Silk is a fibre produced by the silkworm of the *Bombyx mori*, or silk moth, which feeds on the mulberry plant. It is a poor conductor of heat, and will take up a large quantity of moisture without feeling damp, though in this hygroscopic quality it does not equal wool. It does not irritate the skin nor does it shrink like wool.

Linen is made from a fibre obtained from the flax plant, *Linum usita-*

tissimum; the fibres are jointed and cylindrical. Linen cloth is fine, smooth, and of close texture; it is a good conductor of heat and a poor conductor of moisture.

Cotton is also a vegetable fibre, obtained from the *Gossypium herbaceum;* the fibres are spun into thread, and thus used to make cloth, which has a smooth texture of varying degrees of fineness. Cotton is absorbent and rapidly parts with heat in consequence of re-evaporation.

Hemp and jute are vegetable fibres that are spun into coarse fabrics, which are sometimes used for clothing.

Choice of Clothing.

The choice of clothing is largely a matter of climate and of season, with the added factor, as in the case of food, of temperament. One individual will wear a suit of thin cotton gauze underwear all the year round, another will wear wool, and another silk in the same latitude.

As air is a bad conductor of heat, a fabric which is woven so that its pores will contain a quantity of air is warmer than one that has a fine, thin, close mesh. If there is wind the air in the mesh of a thick cloth is renewed, evaporation is hastened, and in consequence there is increased chilling of the surface of the body; on this account it is necessary in cold, windy weather to wear furs and thick woollen clothes, several layers of clothing being worn, the number varying with the need of the wearer. A fabric containing India rubber or some preparation thereof, such as in the Mackintosh, is warm on account of its impermeability, but, inasmuch as it induces copious perspiration, the consequent danger of chilling renders a material of this kind less desirable than heavy woollen goods, except for use in very stormy weather.

Under-garments.

In a temperate climate, where long periods of summer heat and humidity are rare, woollen under-garments are best for wear the year round; but even the fine light-weight woollen garments are unendurable in many parts of the United States during summer weather, and only cotton or linen is tolerated, loose clothing best serving to protect from the heat, because it favours a free circulation of the air. Winter underclothing should correspond to the shape of the figure, covering the entire upper part of the chest and shoulders, fastening on the shoulder instead of in front, and having a double thickness of cloth in that portion of the chest region which will lie beneath the outer shirt where the vest is open. This clothing should not compress the chest or arms, and the combination suits of undershirt and drawers in one piece are very desirable, especially for women, because there is no drawer band to compress the abdomen. Where wool irritates the skin a thin gauze or silk garment may be worn next the skin and a medium-weight woollen garment over it.

The frequency with which underclothing must be changed will depend

upon the habits of the individual in regard to bathing and upon his tendency to perspire.

The linen shirt so popular to-day is nothing but a starched breastplate, but the fine cambric shirts worn by gentlemen a century ago, or the plaited bosoms once so familiar in the southern part of the United States and still used there, are clean, fresh, and cool.

Outer Garments.

The colour of the fabric of the outer garments is an important detail. White absorbs one half the heat that black garments do; so in summer the various shades of light-coloured cloths should be selected for cool clothes. While a coat may fit snugly, it should not restrict the movements of the chest or arms by being tight, nor be oppressive in weight in consequence of padding. The vest is a desirable garment to protect the abdomen, and, when the aperture from the neck downward may be long or short, the space may in cold weather be filled in by a scarf, or a chamois or flannel chest-protector may be worn.

Hats.

Hats should have a space between the top of the hat and the hair, and they should be provided with ventilating apertures in the top or at the sides to facilitate the escape of the heated air. Open-work straw hats are quite cool for summer use—more so, perhaps, than the helmets worn in tropical and subtropical climates. A hat should have a broad brim to protect the eyes from the sun; and the large felt hat, worn in the Southern United States and by troops in the field on the frontier is an excellent covering.

Women's Dress.

To attempt to discuss the hygiene of woman's apparel, or to fulminate against the ills induced by corsets and the weight of several garments about the waist, is supererogatory. The increasing popularity of outdoor exercise among women is likely to do more to secure sensible dress than all the criticism heretofore written from a medical standpoint. Bicycling and horseback riding especially have served to popularize the combination under-garment, skirts are in the way, stiff corsets can not be worn, and tight lacing is impracticable. So much is being written about the evolution and habiliments of the coming woman that the writer feels incompetent to prophesy her choice of garments or to make suggestions that would pass unheeded, because the dictates of fashion must be followed.

Stockings and Socks.

Stockings and socks are made of almost all kinds of fabrics, and the season of the year will govern, as a rule, the selection of the material. Women and children, whose legs are not protected by their garments as are men's, should wear in winter heavy woollen stockings over the legs of long woollen or silk drawers; this will prevent the chilling of the lower extremities, which is so often associated with the use of lisle-thread or silk stockings, in

women a prevalent cause of uterine disorder. Stockings should not be supported by circular garters worn above or below the knee, but by suspenders attached to the waist.

Boots and Shoes.

Boots and shoes should be made of good pliable tanned leather, with strong soles of oak-tanned leather; the light-coloured leathers are excellent, being cool and comfortable. Impermeable glazed or patent leather is an undesirable material for shoes, as it retains the heat and moisture of the foot, keeping the skin bathed in perspiration, which sometimes has a fetid odour. India rubber, while an excellent article for overshoes in wet or snowy weather, or for boots which are used in walking through wet grass or standing in water, is not a suitable material for shoes for daily wear, as this material is impermeable, like patent leather.

If shoes are not made to order so as to conform to the shape of the foot, the purchaser should note that a ready-made pair has a straight edge to the inner side of the sole, in order that the great toe shall not be displaced. While broad-toed shoes are not attractive, perhaps, they are certainly as pleasing to the eye as the sharply pointed shoe, which endeavours to make the external covering of the foot resemble one of the digits of a bird. Unless the sharply pointed shoe is much longer than the foot the toes will be so compressed and deformed that an operation may be required. The greatest care should be exercised in selecting children's shoes, for the delicate and tender structures are easily affected by a badly fitting shoe.

In summer time, and in localities where there is but little dust, low shoes are cool and convenient. For general wear the ordinary laced or buttoned shoes, reaching a little above the ankles, are excellent. For people with sluggish circulation, or those who suffer with cold extremities, boots are advisable. The weight of the leather of which the boot or shoe is made necessarily varies with the uses the wearer makes of it; the same thing may be said of the sole, which should always be wider than the foot and sufficiently heavy to prevent moisture or cold penetrating the leather in walking. Heels help to keep the foot off the ground, but they should be broad and low and not cut in the fashion known as French heels, which throw the weight of the body forward on the toes. Children's shoes should not have heels. Fortunately, there is a growing appreciation of the intrinsic beauty of a normal foot, and the use of tight shoes will be less popular.

CHAPTER XII.

HYGIENE OF INFANCY AND CHILDHOOD.

Nothing is more essential to the future welfare of an individual than the hygienic surroundings during infancy. While sturdy, vigorous individuals have developed in unsanitary environments, such a result is rare. A large proportion of infants so situated die before their fifth year, or acquire systemic weakness that results in premature death during adolescence or early manhood. The development of the individual may be divided into three periods: infancy, from birth to the completion of the first dentition; childhood, from the first dentition to puberty; and adolescence, from puberty to full growth.

Whether parents are able or unable to afford the luxury of a nursery, it is important, above all things, that the house should be in a healthy locality and that its sanitary arrangements should be satisfactory. The room in which children are to be brought up should be the brightest, sunniest room in the dwelling, preferably having a southern exposure, with morning rather than afternoon sun; such an apartment should be well ventilated, for plenty of air is as essential as plenty of light to a growing child. Furthermore, as the bedroom must often serve as the hospital in which the diseases of childhood are treated, means for securing an abundance of light and air are doubly essential.

The Nursery.

The floor should be of fine-grained, closely joined, smooth boards, or of parquetry flooring, which is particularly well adapted for the nursery, its patterns being such that they will amuse the child. Where the expense of parquetry or of hard-wood flooring can not be incurred, a carpet cut in the form of a rectangular rug may be used; such a rug can easily be removed from and replaced in the room in case of sickness of a contagious nature, but it is likely to be soiled by the child's discharges or food, and must be cleansed annually at least.

The woodwork of the room should either be of the natural wood, filled and varnished, or painted with some light-coloured paint that will easily show the dirt. The nervous system is sensibly affected by different colours—yellow attracts the nerves of sight, red excites, green soothes, blue renders them torpid—and judgment must be shown in the selection of colours for the walls and ceiling. The walls should be so constructed and prepared that they may be painted and varnished, though varnish turns yellow with age, and such a wall loses its clearness and freshness in the course of time; still it is more easily cleaned by being wiped down with a moist sponge than is a wall covered with paper or tapestry. If wall paper is used, an ordinary tinted paper with dado below and lighter

colour above is cheap and durable, and very attractive designs are prepared for use in the nursery. In buying papers care must be taken to select a trustworthy dealer who will not furnish papers coloured by arsenical pigment. This careful selection of attractive tints for a nursery will insensibly educate the child to appreciate good colours.

Furniture should be of light-coloured wood, so that by showing the dirt it will indicate the necessity of being cleaned, and it should be light in structure, so that it may be easily moved. The Vienna bent-wood furniture, or oak or ash furniture, are excellent for a room used by children. There should not be much carved work in order that dust shall not be harboured. Thick, heavy upholstery and curtains are unadvisable; the light should be freely admitted, and nothing but curtains of white goods that may be easily washed should be used. Shades may be of dark material, to exclude the light when desired, or Venetian blinds, which, while excluding light admit air, are useful.

An open fireplace with a gas fire is very desirable for its ventilating effect, but a coal fire makes so large an amount of dust that the usual method of heating by hot air, steam, or a stove is to be preferred. An open fireplace must be protected by a strong wire screen or fender, but the latter must not be used to dry diapers and thus vitiate the air. If the heating is by hot air the registers should be placed some distance above the floor so as to avoid floor draughts and to increase the circulation. There should be ventilating outlets at the ceiling, or the air may be changed by some of the means referred to in a former portion of this article. As there is great loss of heat through window glass, there is a constant current of cold air descending in front of a window. This may be lessened by the use of a double sash, which may be put in at a small expense and which affords excellent ventilation.

While it has been held by most authorities that a uniform temperature of 65° Fahr. is good for a nursery, many think that a temperature of from 70° to 75° Fahr. is necessary during the day, though a lower temperature is requisite at night. As artificial lights, except electricity, not only give off heat but consume the oxygen of the air, it is inadvisable that a light be kept burning at night in a nursery; furthermore, if the light is at all high it is likely to make the child's sleep restless.

However convenient stationary plumbing may be in a nursery, it is objectionable because it is so likely to become fouled by the accumulation of filth, pins, thread, etc., in consequence of washing diapers in the room.

Washing an Infant.

Water for the baby's bath should be warmed to from 98·4° to 100° Fahr., and ought always to be tested by a bath thermometer; when the child is a few months old and in summer this bath may be followed by a cooler one, and the temperature of the water may be gradually reduced to 90° Fahr., while in the second year

from 75° to 70° Fahr. should not be uncomfortable. The child should be placed in the tub and briskly rubbed in order to stimulate the activity of the skin as well as to bring fresh water in contact with the surface of the body. Care must be taken to choose a bland, pure soap that will not irritate the delicate skin of the child, and a sponge or soft wash rag should be used. It is easier to soap a very young infant while it is lying on a bath towel or folded sheet on the nurse's lap, subsequently transferring it to the tub, where it should have its head supported so that it will not get water in its eyes and mouth, and where it may be encouraged to exercise its limbs. After the bath the child should be carefully dried with a soft Turkish bath towel, the rubbing being gentle and effective. A bath should not be given when the stomach is full, after a meal, or when it is empty.

The use of powder after a bath is a firmly rooted custom that need not be observed if the child has a healthy skin that is thoroughly dried; but in some (especially fat) children there is a tendency to chapping in the skin of the groins, buttocks, and other regions where there are cutaneous folds, and a little finely powdered talc combined with boric acid is useful. If the skin is very sensitive a pint of wheat bran in a bag or a teacupful of common salt may be dissolved in the bath.

The scalp should be kept scrupulously clean, and the hair may be brushed with a soft brush that should from time to time be thoroughly washed.

Care of the Mouth and Teeth.

The mouth should be washed daily with a piece of soft cloth moistened with a solution of salt water of a strength of one per cent.; as soon as several of the milk teeth appear a soft toothbrush should be used, a few drops of a solution of Castile soap and oil of wintergreen in water making a good dentifrice. The early teeth should be carefully inspected by a dentist from time to time, and on the first appearance of a spot of decay the affected tooth should be filled. If decayed, the first teeth are likely to interfere with mastication and to influence the development of the permanent teeth. The first teeth should not be removed unless they are interfering with the eruption of the permanent teeth.

Infants' Clothing.

The clothing of infants should be light, soft, and warm, and easily put on and taken off, the quantity and quality varying with the season. The clothes must allow free expansion of the chest and stomach, as well as freedom of the limbs. As a child's animal heat is easily disturbed, a poor conducting material should be selected for the clothes. Light wools in summer and heavier woollen goods in winter should be the rule, so as to avoid chilling from sudden changes of temperature. There is a tendency to overload the infant with a number of skirts or dresses, which are usually too long; these are unnecessary for either warmth or comfort. A fine, soft woollen shirt reaching well

over the chest, covering the arms, and extending below the buttocks, is the first covering; often this is supplemented by the protection and support afforded by a binder, cut bias to secure easy expansion, of flannel placed about the abdomen. Over this is placed a flannel skirt which extends some distance below the feet, and finally the outer dress, of such material as may be fancied. The napkin should be made of medium-weight cotton goods—linen is too cool—which must not be too bulky when applied, which should be changed as often as necessary, and which should not be used a second time until washed. Knitted socks, without shoes, are the best foot covering. All clothing must be thoroughly dry. Heavy hats or bonnets must be avoided.

As soon as the child commences to use its limbs freely the dresses and skirts should be shortened, and it should be given every facility to exercise its limbs and learn to crawl.

As the child grows older, drawers may be substituted for napkins, the clothing becomes shorter and should be supported from the shoulders, there must be an absence of all tight bands that will compress parts or restrict free motion, the stockings become longer and are supported by suspenders attached to the waist of the shirt, and broad, easy, heelless shoes of soft leather are worn.

If the use of flannels causes prickly heat, muslin or linen underwear should be worn next the skin.

When the child is a week old in summer, or a month old in winter, it should be taken out so that it can get fresh air, except on very windy, very cold, or rainy days. The child should be placed in a baby carriage, it should be covered according to the character of the weather, and the carriage should be propelled in a direction in which the wind will not blow or the sun shine directly in the child's face. It is an advantage to have delicate children sleep in the open air in the carriage on bright, dry days.

Feeding an Infant.

Dr. L. Emmett Holt advises that a child should be fed four or five times daily during the first three days of life, as it can only obtain a small quantity of milk from the breast at each feeding; no other food but that which is naturally provided should be given a very young infant, and it is very objectionable to give them gruels or baby toddy. When the milk begins to flow abundantly, about the third day, the infant should be nursed every two hours during the day and twice during the night, each breast being suckled for about ten minutes and washed clean after nursing. When six weeks old the interval between the feeding may be made two and a half hours, and when three months old the interval may be increased to six hours. In the fifth month the baby need not be fed between nine o'clock at night and six o'clock in the morning. If the mother's milk is insufficient in quantity

or quality the child may be partly or wholly fed artificially; but as the mother's milk is, as a rule, the best food for the child, every effort should be made to nurse it until it is weaned in the ninth or tenth month. Nursing prolonged beyond a year is likely to injure both the mother and the child. In the second year the child may be fed four or five times a day.

Mother's milk contains thirteen parts of solid matter and eighty-seven parts of water. The solids consist of a fat (cream), a carbohydrate (sugar of milk), a proteid (the curd), and salts. Cow's milk contains three times as much curd and about half as much sugar as woman's milk, so certain additions should be made to it in order to fit it for infant's food. Skim off the top milk from a bowl that has stood for at least six hours, and to eight ounces of this, or to four ounces of cream, add six heaping teaspoonfuls of milk sugar (four of cane sugar) and sixteen ounces of barley water. The latter is made by boiling one tablespoonful of barley and one pint of water for six or eight hours, adding water as it boils away, and finally straining through a cloth and adding a little salt; this will keep for forty-eight hours, though it is better to make it fresh daily, and in summer it must be kept on ice. Milk prepared as above directed, Dr. Holt says, may be given to a child until it is seven or eight months old; then the quantity of milk in the mixture should be doubled and the milk sugar be increased one third. While condensed milk has had great popularity as an infant food, it contains too much sugar and too little cream, so it should be diluted with water and cream added in order to secure fat. If a child's food does not contain enough fat the bones become soft and the muscles flabby; it is on this account that so many of the children's foods are valueless.

Bottles used for infant feeding will be filled with bacteria likely to give rise to gastro-intestinal disorders, unless they are thoroughly cleaned by being washed in hot soapsuds, then transferred to boiling water for fifteen minutes, and gradually allowed to cool in the water. Black-rubber nipples should be used, and these may be kept in a fifteen-per-cent. solution of boric acid and washed just before feeding.

Dr. L. E. Holt gives this excellent dietary for a child eighteen months old: First meal at, 7 A. M., a tablespoonful of some cereal with salt and one tablespoonful of cream, half a pint of milk. Second meal, at 10 A. M., half a pint of milk. Third meal, at 1 P. M., one tablespoonful of scraped meat, two small pieces of dried bread, half a pint of milk. Fourth meal, at 4 P. M., eight to twelve ounces of milk. Fifth meal, at 7 P. M., milk with farina or arrowroot. During the third and fourth years four meals a day will suffice, eggs, meats, and vegetables being given.

A child should always have a bed for its sole use. The bed should have no curtains, the hair mattress should be soft and firm and rest on

springs, the pillows thin, and the covering moderate. Most mothers cover their children too heavily and keep them bathed in perspiration during their sleep. In summer a child's bed should be provided with a mosquito bar to protect it from the flies and mosquitoes. Young infants will sleep about nine tenths of a day, a one-year-old child about two thirds of a day; older children will take a nap during the day until their fourth or fifth year. The infant should be put to bed at seven o'clock, the young child at eight, and either should be allowed to sleep undisturbed. Nothing is more injurious to the nervous system of a child than to awake it at a certain hour in the morning; the child is excited, the heart's pulsations increased, and there is a state of agitation. Sleep is a physiological necessity, and a parent may rest assured that if a child sleeps a very long time it is because the nervous system needs the rest afforded by slumber.

Sleeping Arrangements.

After childhood is well established—that is, in the fourth year—the child should be educated to use its mind; because as the muscles of the body become stronger through use, so is it necessary for the brain to be used, in a somewhat systematic manner, to develop the mind. There is no better beginning than the admirable plan elaborated by Froebel, known generally as the kindergarten system. This occupies the child's time to some purpose, teaching it how to use its faculties in the recognition of form, colour, action, etc. It is too much the custom to keep children out of school because it is not deemed advisable to force their mental powers; but a few hours' schooling a day is not likely to force their powers, and it does give the child a valuable training as well as relieves it of the *ennui* incident to unoccupied time.

Early Education.

Time well occupied is as necessary for the happiness and welfare of a child as for an adult. Sufficient sleep, good air and light, daily bathing and exercise, and mental occupation will do much to prevent the ills that infantile flesh is heir to.

If the child is likely to have any supposedly hereditary diseases, if one or both of its parents are tuberculous, if it is very large or very thin, if it is easily fatigued, if it has an unhealthy, anæmic appearance, great care must be taken that its nutrition is sufficient. It should be placed under medical care, and by the judicious employment of hydrotherapy, gymnastics, dietetics, fresh air, and sunlight, the bad condition may be cured. In such a child intellectual work should not be prolonged, though it should not be omitted. A child predisposed to constitutional diseases may be so built up that its organism will resist them, and all traces of the inherited diathesis will disappear. The child of nervous parents, living in the environment in which it was born, is likely to cultivate various functional nervous diseases; but placed in surroundings where its tendencies are

General Hygienic Considerations.

recognised and intelligent methods are adopted to repress them, such a child may reach adult life free from nervous disease.

Puberty.

During infancy and childhood the vital powers are engaged in the nutrition and growth of the individual, but at the period when the reproductive capacity becomes established there is an evolution of organs that are concerned in the perpetuation of the species. There is no fixed time for the appearance of puberty. Climate, race, heredity, temperament, occupation, and physical condition influence the beginning of that epoch. The old custom of basing the advent of puberty in a boy upon his sexual capacity is fallacious. The advent of male puberty occurs when the various physiological changes of alteration in the modulation of the voice and the growth of down on the face and of hair on the pubes commences. In girls puberty dates from the first appearance of the menstrual flow, which may commence before the twelfth, and usually appears during the fifteenth year ; and the change is accomplished more quickly than in the case of the opposite sex. The girl reaches maturity more rapidly than the boy.

This is a period of life which should be regarded as full of risk and demanding careful consideration in both sexes, for if the body has not been well nourished during childhood, if there is any factor that has caused excessive nervous development, there is the probability that the late puberty will so tax the individual that subsequent ill health, either physical or mental, will follow. Too often is seen at this time what Herbert Spencer has characterized as "that antagonism between body and brain which we see in those who, pushing brain activity to an extreme, enfeeble their bodies."

Care of a Boy at Puberty.

The education and habits of a boy at puberty should receive careful supervision. He should be taught, if not by his father at least by the family physician, what the significance of the change is. If there is any tendency to organic weakness his exercise and diet should be regulated, though this is needless in the case of a healthy boy. His mind should be well occupied. He should sleep alone, and on a hard bed. His room should be well ventilated, and he should take a cold bath every morning. If there is evident nervous disturbance the physician may prescribe each night a dose of potassium bromide, or such other drug as he may see fit, for a boy may, like a girl, have at this time hysterical or other nervous disorders, and even perverted mental or moral excitability, sometimes with delusions.

Care of a Girl at Puberty.

Girls are, unfortunately, particularly liable to nervous disturbances connected with the establishment of menstruation, and even moderate hysterical symptoms may indicate serious utero-ovarian irritation or disease that should be treated by the physician. Insanity, epilepsy, trance, or paralysis may

result from untreated hysteria associated with commencing menstruation. There may be a diminution in the quantity of the menstrual flow, or it may be absent or too frequently repeated; such cases demand medical rather than home treatment. *The custom of administering alcoholic drinks at this time of life for remedial purposes can not be too strongly deprecated.* Social station has little influence on freedom from such disorders. In fact they are more likely to occur in the children of the rich leading sedentary lives than in those of the poor whose fate it is to engage in some healthful kinds of labour at an early age. Too much work does harm, and under overstrain there result debility and incapacity for ordinary functions, and perhaps premature exhaustion.

Dress is very influential in affecting the developing woman. The appearance of menstruation is considered by many mothers as an index for the use of corsets, so this compressing band encircles the waist, forcing the weight of the intestine upon the newly developing sexual organs. Is it then a matter of surprise that, in consequence, the uterus is displaced from its normal position and the Fallopian tubes and ovaries are irritated, while the upward displacement of viscera affects the action of the diaphragm and limits free expansion of the lungs? Loose, easy dress, supported by the shoulders, not the waist, is more essential to a girl at puberty than immediately after her birth. No girl can ride a horse or a bicycle easily, or play lawn tennis, or engage in the other popular sports of the day, unless she has plenty of chest capacity for increased action of her heart and lungs when exercising.

Mental, Moral, and Physical Training.

At all periods of growth the culture of the mind should be subordinated to the furtherance of moral culture and the development of physical stamina. It is a matter of common observation that faulty posture at school, at home, or induced by occupation, and over or under exercise, cause insufficient chest and muscular development and bodily asymmetry. An increased popularity of all outdoor sports and games, and a recognition of the advantages afforded by systematic gymnastic drill in a well-lighted, well-ventilated gymnasium, whose instructors recognise that similar muscles have not equal power in all individuals of the same age, must have a beneficial effect on the improvement of the individual. The results afforded by the investigations of the physiologists indicate that the exercise of the muscles directly exercises certain regions of the brain, thus indirectly improving the circulation and nutrition of that organ of the mind. But exercise must be calculated to bring most of the groups of muscles into play; not limited, as is walking, to the growth of the muscles of the lower extremities of the body, or, as in rowing, to the play of the muscles of the upper extremities and back. The scope of exercise is more fully considered in another article in this volume.

One of the most disastrous occurrences during this period is precocious indulgence or abuse of the sexual instincts or appetites, resulting in a premature breakdown of the constitution or in the production of a number of maladies of adult life. Mental and physical debility are the consequences of such abuses, and their prevention is a matter for the consideration of the moral teacher rather than the hygienist. As such excesses produce their chief deleterious effects upon the nervous system, so does the use of alcohol or tobacco at this period result in most injurious consequences to the nervous organization; alcohol and tobacco are not only unnecessary, but they are poisons that are only tolerated by their *habitués* in consequence of long usage.

Abuse of the Sexual Instincts.

CHAPTER XIII.

HYGIENE OF OLD AGE.

THE hygiene of old age is a very extensive subject, which can be considered only in a general way in these pages. With increasing years there is gradual and progressive impairment in the structure and functions of the whole body, and it is requisite, in order to preserve health and retard the natural decay, to impose no greater task upon any organ or system of organs than its reduced power or capacity can discharge.

All undue mental excitement or depression must be avoided, and the brain should not be overworked by prolonged mental labour, or operations in business which involve great strain and anxiety. Mental labour is an essential to those who have always been brain workers, but such labour should not be carried beyond the point when slight fatigue is experienced; a moderate exercise of the mental faculties is "conducive to a healthy discharge of the cerebral functions," which, through the brain, has a salutary influence on the entire system. Idleness and listlessness are as likely to lead to degeneration and atrophy of the brain as is overwork. If the mental faculties have been mismanaged during adult life there is likely to be more or less aberration from a normal standard, causing the peculiarities, or, to adopt the vernacular, the crankiness of old age.

Mental Activity.

The lessened capacity of the stomach and its decreased muscular power and nervous energy indicate the necessity of moderation in eating and drinking and the use of those foods that are both nutritious and easily digested. A mixed diet is most suitable in old age, those vegetables and meats being selected that are easily changed by the smaller quantities of gastric and intestinal fluids. More

Diet.

liquids than solids are needed, although there is a diminution in the quantity of perspiration, the lungs exhale less moisture, and the kidneys do not excrete urine as in adult life. Too large a quantity of fluids, however, unnecessarily dilutes the gastric juice and diminishes its solvent power as well as delays the other processes of digestion. Those who have a good appetite should eat oftener, rather than chance overloading the stomach by a heavy meal, which is digested so slowly that ferments may be produced which, when taken into the system, act as poisons. Meats should be tender and neither overdone nor underdone; roast beef or mutton free from fat and gristle, poultry, and game are digestible; pork, salt meats, veal, and lamb are indigestible and should not be used. Spinach, potatoes, cauliflower, Brussels sprouts, asparagus, and raw tomatoes are preferable to cabbage, carrots, and turnips. The ability to digest white or sweet potatoes varies with individuals, though these vegetables are better digested when baked. While most fish are digestible, shellfish, especially lobsters and crabs, salmon, mackerel, and eels are undesirable. Soups should be free from fat and large quantities of vegetables. The stimulant and sedative effects of tea and coffee are useful in the weakened tone of the stomach in advanced years. Plain simple dishes are to be preferred to a variety of *entrées* served with rich sauces. The quantity of food should be commensurate with the expenditure of tissue in mental and physical exercise. Milk and eggs are among the best food stuffs for the aged, and if starchy foods are given, malt preparations may have to be administered, because there is not sufficient saliva or pancreatic juice to make the first change in the digestion of carbohydrates—their conversion into sugar. Food should be made appetizing by good cooking and the skilful use of condiments, though it is to be remembered that the will-power in old age often assumes the vacillating character of youth, and if food is particularly inviting the aged may give way to gluttony or over-indulgence. The moderate use of fermented or malt liquors is often of advantage, for they stimulate the healthy discharge of the gastric functions. Sherry, port, and Madeira are often found beneficial, though their use is usually unnecessary in those who have been unaccustomed to the use of alcoholic drinks.

Exercise.

Exercise is as essential to the welfare of the old as to the young. The particular form selected must be determined by the physical needs of each individual. It is important to take exercise as far as possible in the open air. When the weather interferes with outdoor exercise massage may be substituted. Light work in a garden is very useful as a means for calling most muscles of the body into play.

As there is a diminished power of generating and preserving heat in the aged, it is necessary for them to wear warm clothing in order to prevent the possible evil effects of chilling the body. Woollen underclothing,

of different weights according to the season of the year, should be worn; furthermore, it is desirable for the aged to use chest protectors, abdominal bands, and knee protectors during cold weather, as the chest, abdomen, and knees are particularly apt to be affected by the temperature. Those who suffer greatly from the cold should use two suits of underwear—silk next the skin and wool over the silk; such an arrangement is necessary for those whose skin is irritated by wool. Cotton instead of linen sheets should be used.

Clothing.

The skin, like the other organs of the body, loses the activity of its functions in old age; it becomes dry, withered, and scaly, and does not carry off effete matter from the pores, which are contracted; its action should therefore be furthered by frequent bathing with the friction of a bath glove or flesh brush, the body being dried by a Turkish towel. Tepid baths followed by a cold or cool shower bath are most useful.

Bathing and Sleep.

Sleep is variable in the aged, some sleeping several hours a day as well as through the night, others, while retiring early, awakening at an early hour in the morning. For the repair of tissue waste and for rest for the nervous system sleep is as necessary in old age as in infancy. The room should be quiet, the temperature and air supply carefully regulated, and the bed covering sufficient for warmth without being heavy. An afternoon nap, if it does not prevent sound sleep during the night, is both pleasant and healthful.

With the diseases of old age this article has nothing to do, but whether the labour and sorrow of old age referred to by the psalmist is to predominate will depend entirely upon the early life of the individual. Oliver Wendell Holmes said something about preferring to be sixty years young rather than forty years old, and a well-regulated life will as assuredly lead to a mellow old age as will an ill-regulated life eventuate in a decrepit maturity.

CHAPTER XIV.

HYGIENE OF BRAIN WORKERS.

The nervous system of the brain worker is constantly exercised, while in many cases the muscular system is used only at rare and irregular intervals. There is more or less torpor in the performance of the functions of the organs, and the individual is subject to various disturbances. The brain-cells must be kept in good order for the healthy operation of the mind; their nutrition must be well maintained, as they do not act well

when the body is stuffed with an indigestible or overwhelming amount of food or when it is starved. For the nutrition of these cells it is quite necessary that the individual should have a good supply of oxygen; insufficient air soon becomes vitiated, and when respired interferes with the best action of the mind.

Signs of Mental Fatigue.

One of the first signs of mental overexertion is the intrusion of unwelcome thoughts or unpleasant suggestions without relevancy to the work or line of thought in which the individual is engaged. This is followed by poor sleep, in which there are frightful dreams or there is insomnia. When such conditions ensue, work should be stopped and a physician consulted.

As a result of the fatigue, exhaustion and temporary powerlessness of the brain tissue ensue; the sympathetic nerves normally contract upon the blood-vessels which they accompany and diminish the supply of blood to the brain, and thus produce sleep, but in morbid wakefulness the sympathetic nerves lose their grasp upon the capillaries of the brain, to use Dr. D. H. Tuke's expression, and the gray matter persists in keeping up its molecular activity, which may at first produce brilliant results, but is more often imperfect and intermittent, finally ending in vague, irregular, and indefinite mental action. Instead of stopping work at the right time in order to recruit itself the brain goes on acting, and when eventually its action is suspended and the supply of blood is shut off, such an irritability has been produced in the nerve tissue that the sympathetic nerves are unable to control the vessels, and the brain's action recommences before it has had sufficient rest following the preceding day's work.

Sleeplessness, dull headache, singing in the ears, a sense of fulness in the head, inability to do an amount of mental work once easily performed, powerlessness to read any book that demands the slightest continued attention, listlessness, and inaptitude for the duties of life are some of the symptoms indicative of the exhaustion of the brain and of the necessity of rest, if not of medical advice.

Activity and Repose.

As the nature of the individual absolutely demands activity, so it requires repose. Next to sleep, rest from work is a necessity for the brain worker. This rest may be best obtained by taking exercise; or, if this be impossible, by indulging in some amusement such as billiards, whist, chess, or some similar game.

Diet.

The diet of the brain worker should be digestible and easily assimilable, the food should be properly cooked and seasoned, the meals taken at regular hours not too long separated, alcoholic stimulants should be eschewed, and the first symptom of indigestion should receive the attention of a physician. If food is taken in too great excess and especially thus taken at long intervals, it will not

be digested and absorbed. Nitrogenous foods are most relished by brain workers, who are likely to associate with their use large quantities of coffee and tea.

Pure air, good light, regular hours of mental work, exercise, good diet, bathing, and that exercise of the will requisite to maintain cheerfulness are the measures which will secure the best mental work.

CHAPTER XV.

OFFENSIVE TRADES OR OCCUPATIONS.

THERE are a number of trades or occupations that are offensive and prejudicial to the health of a community, and they may be included in one of the two classes: 1, Trades or business in which raw materials of an animal or vegetable nature are employed; 2, manufacturing processes that evolve noxious gases or vapours.

In most cities there is a municipal ordinance which forbids within the limits of the municipality bone boiling, bone burning, bone grinding, skinning dead animals, or boiling offal, or the maintenance of any place of business dangerous to life or detrimental to health, where unwholesome, offensive, or deleterious odours, gas, smoke, deposit, or exhalations are generated.

Slaughter Houses.

Slaughter houses should not be allowed within municipal limits, because they pollute the atmosphere, there is likely to be an accumulation of filth about the premises, which are kept clean with difficulty, and they are infested with flies, which are likely to carry the germs of tuberculosis, malignant pustule, or some other disease to healthy persons, or to deposit these germs on cooked food stuffs.

The blood of animals is used for a number of purposes; mixed with fat and condiments, it is used for blood pudding; or alone, it is used to feed pigs; or the serum may be separated from the clot so as to get the albumin, and the clot is used for manure, the manufacture of Turkey red, and other purposes. The fat of pigs is used to manufacture lard, while that of cattle and sheep is used for manufacturing fat and oleomargarine. Of the viscera, the first stomach of cattle and sheep is cleaned to make tripe; the second stomach and small intestine may be used to feed pigs or dogs; the small intestine may be used to make sausage skins or for the manufacture of scraped guts; the large intestine may be used for human food; the heart and lungs are used by some people for food, while the liver and kidneys are frequently thus utilized. The utilization of the

materials constituting the carcass of an animal becomes a nuisance in consequence of the bad condition of the premises where the work is conducted; or because of the accumulation of material which is to be converted into mercantile products; or on account of the odour from the boiling or other treatment of the articles.

Manufacture of Glue and Soap.

The manufacture of glue from the bones, hoofs, horns, scraps of skin and leather, etc., may be attended with great nuisance in consequence of the foul odours from the boiling material or from the residue left after boiling. Soap manufacture may be a nuisance in consequence of the offensive odours from some of the fats used; this may be prevented by suitable apparatus. Bone boiling is likely to produce very unpleasant odours, and the effluvium should be carried through a furnace to very high chimneys.

Conversion of Hides into Leather.

The conversion of a raw hide covered with hair and putrescible material into leather may be carried on without nuisance. The latter is caused by the bits of flesh, fat, hair, and skin which are allowed to accumulate on the premises and putrefy and foul the air. The water in the tan pits may be emptied into and pollute a stream. The first-mentioned objection may be corrected by cremating the refuse, and the second by filtration and precipitation of the water.

Artificial Manure.

The manufacture of artificial manures is very offensive on account of the odours given off by the works. The vapours produced in the manufacturing processes should be burned in a furnace or condensed by a cold-water shower bath. The use of air-tight receivers will further limit the effluvium so that no serious nuisance will result.

In a number of manufactures unpleasant odours or refuse are produced; the former may be obviated by propelling all vapours by a fan through water, to a furnace, where they are consumed in part and discharged by a high chimney. The manufacture of bricks, Portland cement, lime, gas, and of substances containing arsenic, mercury, chromium, lead, zinc, and phosphorus are often associated with nuisances which are more likely to demand the attention of the health officer than of the amateur sanitarian.

CHAPTER XVI.

COMMUNICABLE DISEASES.

WHILE it has long been known that certain diseases are communicable, under certain conditions, from one individual to another, it was not until the investigations of bacteriologists showed the true character of contagia that the question of the communicability of disease was removed from the domain of speculation. The germ theory of disease rests upon the definite basis referred to in the first portion of this article, and while it does not satisfactorily explain every feature in the dissemination of disease, or finally settle many very profound and complicated questions, it does afford a better reason for the occurrence of disease than anything previously known. The fact that the introduction of a certain germ, always found in the body of a person affected with a particular disease, produced the phenomena of that disease in an animal of another species, afforded logical proof of the relation between that micro-organism and the disease in question. Reference has been made to the fact that the microbial origin of many of the most important of the communicable diseases is a matter of deduction rather than demonstration. Investigation has shown that it is not always the micro-organism itself, but the poisonous principles it produces that originate many of the phenomena of disease processes.

The Germ Theory of Disease.

Certain micro-organisms must be introduced into the system by means of food and drink, others are introduced by respiration. They may be dormant in food or drink, in clothes or furniture, retaining their contagious properties and infecting, long after leaving their original host, another person into whose body they are introduced. See *Diseases in General.*

Communicable diseases include those that may be communicated to another individual by any mediun. Formerly they were divided into contagious diseases or those acquired by direct contact; infectious, or those communicated by air, water, or some other fomites; or zymotic, in which the disease was communicated by a living organism that had the nature of a ferment; or specific, in which the disease originated from some pre-existing case of the disease by means of a specific virus. Such diseases are said to be *endemic* when they are more or less restricted to some particular locality, in which they reappear from time to time, like yellow fever in Havana. An *epidemic* disease is one that appears suddenly, spreads rapidly, and affects a large percentage of the inhabitants of the places where it appears. A *sporadic* disease is one that appears as an isolated case that, apparently, has no connection with a previously existing case.

Classifications, Old and New.

Louis C. Parkes has arranged a very comprehensive table of communicable diseases. They are arranged in Class A, in which the contagion is disseminated by the air, as in the eruptive fevers; Class B, in which the contagion is air- or water-borne, and is constantly present in certain localities, where the disease may become epidemic and the contagion exhibit special virulence; Class C, in which the disease is transmitted from the sick to the healthy by inoculation; Class D, in which a surface lesion is necessary for the introduction of the air-borne contagion, or it may be directly inoculated therein; and Class F, in which the contagion may be introduced by the air or by inoculation. Some of these diseases affect man alone, others man and the lower animals.

COMMUNICABLE DISEASES.

CLASS A. Contagion, usually air-borne	Smallpox.	Whooping cough.
	Scarlet fever.	Influenza.
	Measles.	Typhus.
	German measles.	Erysipelas.
	Mumps.	Epidemic pneumonia.
	Chicken pox.	
CLASS B. Contagion, usually air- or water-borne.	Yellow fever.	Dengue.
	Cholera.	Diphtheria.
	Enteric fever.	Relapsing fever.
	Dysentery.	Oriental plague.
	Diarrhœa.	
CLASS C. Contagion, usually by inoculation	Anthrax or malignant pustule.	
	Foot-and-mouth disease.	
	Leprosy.	Ophthalmia.
	Glanders.	Syphilis.
	Rabies.	Gonorrhœa.
	Vaccinia.	Tetanus.
CLASS D. Surface lesion necessary for contagion, air-borne or directly by inoculation.	Erysipelas.	Septicæmia.
	Pyæmia.	Puerperal fever.
	Hospital gangrene.	
CLASS E. Contagion air-borne or by inoculation.	Tubercle. { Scrofula. / Lupus.	
	Cerebro-spinal meningitis.	

The essential features of the principal communicable diseases are outlined in the table on the following page.

Smallpox.

Smallpox is an acute infectious disease that was once the scourge of mankind, causing about ten per cent. of the total number of deaths. But the introduction of vaccination in 1796 in consequence of Jenner's discovery has materially decreased the prevalence of the disease. The prevalence of smallpox is directly related to the thoroughness with which vaccination is practised; in 1890 the death-rate from smallpox was ten times higher in towns of Switzerland than in Germany; it was thirteen times higher in towns of Hungary,

Disease.	Period of incubation.	Appearance of eruption.	Period of infection.
Smallpox.	12 to 14, usually 12 days.	Second or third day, on face and forehead.	Three to seven weeks.
Chicken pox.	7 to 14, usually 12 days.	First to fourth day of fever, on trunk and shoulders.	Four weeks; until every scab has fallen.
Measles.	10 to 14, usually 10 days.	Fourth day of fever, on forehead.	During initial symptoms and until end of desquamation.
German measles.	7 to 15, usually 14 days.	First to fourth day of fever, on face.	Same as measles.
Scarlet fever.	1 to 7, usually 3 to 4 days.	Second day of fever, on trunk.	End of desquamation and complete disappearance of throat symptoms.
Diphtheria.	2 to 10, usually 2 to 3 days.	No eruption; rash sometimes on second or third day of fever.	Until all discharges have ceased and throat symptoms have disappeared.
Whooping cough.	4 to 14, usually 7 days.	No eruption.	During catarrhal stage and as long as whoop lasts.
Typhus fever.	1 to 14, usually 12 days.	Fifth to eighth day of fever, on back and sides.	While fever lasts.
Typhoid fever.	1 to 28, usually 12 days.	Sometimes spots on abdomen between sixth and fourteenth days.	Until diarrhœa ceases.
Yellow fever.	1 to 7, usually 3 to 4 days.	Jaundice sometimes on second day of fever.	Until fever ceases.
Relapsing fever.	4 to 10, usually 6 days.	No eruption.	Until relapse ceases.
Mumps.	14 to 21 days.	No eruption.	Until swelling has disappeared.
Dengue.	3 to 5 days.	Often an eruption on fifth to eighth day.	Until fever ceases.
Cholera.	2 to 5 days.	No eruption.	After diarrhœa ceases.

forty-two times higher in towns of Belgium, fifty-six times higher in French towns, sixty times higher in Austrian towns, and ninety-seven times higher in Italian towns, than in those of Germany. In Great Britain the mortality was lower than in Germany, but the suspension of compulsory vaccination in certain districts is likely to increase the mortality-rate.

While smallpox usually spreads from person to person by immediate contact with the affected individual or with some article he has used, experience has proved that the contagion may be conveyed by the air to a distance. A person may be within a few feet of a smallpox patient and neither touch him nor his clothing, yet acquire the disease; but that the infection is carried for from three to four thousand feet without the agency of inefficient quarantine or of flies seems questionable.

Dr. Barry traced, in England (Sheffield), the influence of a smallpox

hospital for a circle of four thousand feet. The percentages of households attacked at successive distances were:

0—1,000 feet.	1—2,000 feet.	2—3,000 feet.	3—4,000 feet.	Elsewhere.
1·75	0·50	0·14	0·05	0·02

Mr. Powers, in investigating the infection of households in the neighbourhood of the Fulham smallpox hospital, found that the disease decreased in frequency in circles at radii of a quarter of a mile from the hospital, though the direction of the prevailing wind furthered the prevalence of the disease in a segment of the circle:

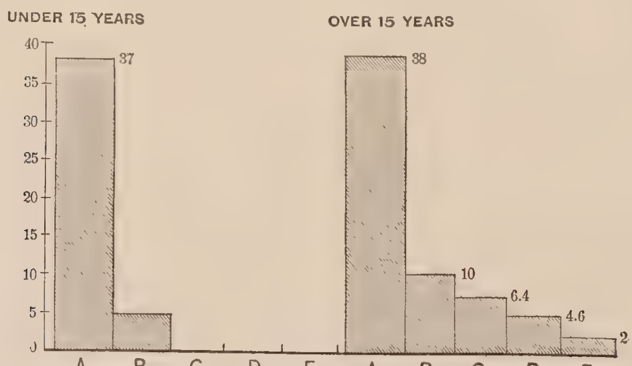
¼ mile.	½ mile.	¾ mile.	1 mile.
11·40	2·93	1·33	0·90

Vaccination.

The efficacy of vaccination depends upon its repetition every few years, calf lymph being employed. If the person vaccinated is protected by a former vaccination the new vaccination will not amount to more than a local scab; but if the individual is unprotected there will be a typical case of vaccinia. The protective influence is lost in the course of time, and it is generally found that re-vaccination at puberty and adult life will be successful. It must not be supposed that a large scar indicates a successful vaccination, for often septic matter is introduced with vaccine and the scar is the result of septic infection. Dr. L. C. Parkes quotes Dr. Collie's statistics that under and over fifteen years of age the mortality percentage of smallpox in the unvaccinated is nearly identical, while the influence of the number and character of scars in the vaccinated is not as important in those under, as in persons over, fifteen years of age. These facts are well shown in the following diagram:

LONDON SMALLPOX EPIDEMIC, 1871, 1881.

MORTALITY PER CENT.



A, unvaccinated; B, those having one or more bad marks; C, those having one good mark; D, those having two good marks; E, those having three good marks.

The diagram shows the ephemeral character of the primary vaccination, for while with one or more bad marks the mortality is reduced to four per cent. in those under fifteen, it is ten per cent. in those over fifteen; and the mortality from smallpox is lessened by the number of good vaccination scars. While occasionally syphilis, leprosy, and septic infection have followed vaccination, it was only in persons who were vaccinated with human instead of bovine lymph; such cases are very infrequent, and vaccination is one of the greatest boons conferred on mankind.

Cholera.

Cholera is a specific infectious disease caused by the cholera spirillum, a micro-organism discovered by Prof. Koch. It is endemic in India, where it has been known for centuries; from that country it was carried as an epidemic, or pandemic. The disease appeared in almost every country during the years 1817 to 1823. A second pandemic commenced in Bengal in 1826, extended over India, thence to Persia, reaching Russia in 1829; from that country it spread over Europe and was brought to North America. A third pandemic commenced in 1846, extended over Persia, and attained its maximum in Europe and the United States in 1848 to 1850; it prevailed more or less extensively in the Western continents from 1852 to 1863, there being apparently a continuous reproduction of the poison in extra-Indian countries. The fourth pandemic commenced in India in 1863, extended to the seacoast of Arabia, and in a few weeks overran a large part of southern Europe. The fifth pandemic commenced on the shores of the Black Sea in 1871, spread over Europe, and reached America. The sixth pandemic started in Egypt in 1883, ravaged southern Europe, and was carried thence to South America. The seventh pandemic commenced in Persia in 1891, extended to Russia in 1892, and thence reached several localities in Europe.

There are three routes by which cholera reaches the Western nations: 1. By traversing India to the Northwest Provinces, then crossing the Khyber Pass on the north or the Bolan Pass on the west into Afghanistan, then travelling onward to Cabul and to Herat, whence it follows the caravan route through Balkh, Bokhara, Khiva, and the country of the Kirghis into Russia. 2. It has spread from southern India up the Gulf of Persia, travelling northward to Syria and Egypt, and northwestward across Persia to the Caspian Sea, thence along the western shore to the Volga, and up that river into Russia. 3. It has been transported to the Red Sea, and thence to the countries bordering on the Mediterranean. By means of vessels it has been carried eastward into China and Japan, and one epidemic in America was introduced from Jamaica, whence the disease was carried directly from India.

The large fairs that are held annually in several places in India are

attended by merchants and traders from all parts of that country, as well as from neighbouring states, and it may be easily understood how it is possible for the healthy to be infected by those coming from localities where the disease is prevailing, and for those infected traders crossing the Himalayas to sow the seed of the pestilence as they travel.

The pilgrimage of the Indian Mohammedans to Mecca is another medium by which cholera is distributed throughout Mohammedan countries. There is a prospect that international sanitary agreement will secure the efficient sanitation of Mecca, and thus do away with this plague spot.

In the *Wandering Jew* there is a picturesque description of the progress of a cholera epidemic at the rate of the distance a man can journey in a day. Wherever pedestrianism, or horse or camel riding, afford the sole means of travel the advance of a pestilence will be at such a rate as is made daily. But these modes have been largely supplanted, and by way of the Suez Canal there is frequent and rapid communication between India and Europe; and the Caspian Sea steamers, connecting with the Trans-Caucasian Railroad, place Russia in quick communication with India. From the reports of the sanitary commissioners with the Government of India it may be seen that in five years, from 1886 to 1890, more than a million and a half of people died of cholera. The Government of that country admits that what has been done in the direction of sanitary reform may appear small in comparison with what remains to be done, but it pleads the ignorance of the masses, their dislike of any change of custom, the lack of sufficient executive agencies, and the want of necessary funds as mitigating circumstances that serve to condone its delinquency. The latter seems the more flagrant in view of the number of capable and distinguished professional advisers it has had during the past thirty years.

As the writer has said elsewhere, while India's responsibility for past cholera pandemics is possibly diminished by the then-existing ignorance of the causation of cholera and the means by which the causative principle was transmitted, our present knowledge shows that that country is as responsible for cholera as are Central America, Cuba, and Brazil for yellow-fever epidemics. However indifferent we may be to the annual sacrifice of several hundreds of thousands of natives of India, however much we may satisfy ourselves that it is but an application of the theory of the extermination of the unfit and the survival of the fit, we can not remain indifferent or satisfied when we contemplate the fact that evasion of the responsibility of being our brother's keeper reacts upon ourselves by perpetuating a disease that may at any time invade the Western World.

The experience of the United States has proved beyond question that a properly administered quarantine will exclude cholera. The existing

system of notification of the appearance in a locality of one of the great epidemic diseases enables our foreign consuls to notify our health officers of the existence of the danger, and enables them to exercise additional care in scrutinizing immigrants from infected countries. The detail of medical officers of the United States to foreign ports of embarkation of emigrants and the careful inspection of these people by competent medical men is another detail that has proved of great benefit in keeping cholera out of the United States.

Dr. Ernest Hart, the able editor of the *British Medical Journal* and an able sanitarian, considers that the disease in question has proved of such value in stimulating sanitary effort that it might appropriately be called "the blessed cholera."

As he has aptly said, we may *eat* cholera, we may *drink* cholera, but we can not *catch* it. In other words, if the purity of the water supply of a community is assured, if its food supply is under the supervision of competent officials, it is unlikely that an epidemic of cholera will enter its boundary. As may be imagined, this entails the isolation of all affected persons who may enter the confines of the community, the disinfection of all discharges, the inspection of all railroad trains, and the preservation of a general state of cleanliness.

An individual in a cholera-infected region must avoid excesses in eating or drinking, or late hours with insufficient sleep and dissipation, or other forms of fatigue. Only boiled water should be used for drinking, vegetables should be well cooked, fruit must be peeled, and care must be used to prevent flies from having access to the food. The infectious principle is contained in the discharges of a cholera-infected person, and if the sick are avoided by all except their proper attendants, and if these attendants are careful to disinfect the discharges and their hands and clothing, it is unlikely that the disease will spread.

Yellow Fever.

Yellow fever is an acute infectious fever occurring in tropical and subtropical countries, characterized by jaundice and hæmorrhages. It may be preceded by a feeling of lassitude and discomfort for several days before the attack, with headache, pain in the back and loins, and lack of appetite. The period of incubation does not usually exceed four or five days, though it may be less than twenty-four hours. The disease begins with a more or less pronounced chill, more or less severe headache, persistent and distressing pain in the loins, which are followed by, and continue during, the fever. With the fever the face becomes flushed, or bright red and swollen, the eyeballs shining and more or less decidedly injected; there are more or less restlessness and vomiting. The pulse, as a rule, is full, strong, and hard, but as the disease progresses it loses its force and rapidity and becomes unusually slow and soft. The tongue is often narrow and pointed, slightly coated,

the margins red, and the entire organ moist, but later in the disease it becomes dry and the coating is brownish. The skin is hot and dry during the commencement of the disease, and then it becomes moist, soft, and cool, though occasionally it remains dry until death occurs; about the end of the second day the skin becomes yellow, the colour varying in intensity from that of an orange to a light yellow, the colour being due to the deposit of blood or bile pigments, or both, beneath the superficial layers of the skin. A notable feature of this disease is the decrease in the quantity of urine excreted and the presence of albumin in the urine passed. While in mild cases there may be but a moderate amount of pain in the head and back, in most cases these latter symptoms are severe and distressing; sleep is fitful and disturbed; there is often excitement, which may end in delirium, or there may be apathy.

A common symptom in the early stages of the disease is vomiting; the matter at first has a yellow colour, but later it has a brown or black appearance, like coffee grounds. This black vomit is due to the breaking up of blood which enters the stomach in consequence of passive hæmorrhage from the gastric mucous membrane. This hæmorrhage may occur in severe cases from the intestine, the bladder, the uterus, and the mouth or nose.

There is a tenderness on pressure over the pit of the stomach, the appetite is poor, and there is a constant feeling of discomfort and pain in that organ. When the fever ceases, especially if the vomiting has been mild, there is likely to be a great desire for food, which, if gratified, will result disastrously to the patient.

The prognosis of yellow fever is uncertain, because a case that appears mild at the beginning may change into a severe type of the fever. The mortality has ranged in different epidemics from fifteen to eighty-five per cent., the natives of a locality where the disease occurs suffering less than unacclimated residents. In those exposed to hardships, in heavy drinkers, and in individuals who lead dissipated lives, the disease is most severe. The negro is less susceptible than the white race to the fever; males are more frequently attacked than females.

Surgeon-General George M. Sternberg, U. S. A., who studied the subject of the bacteriology of yellow fever more exhaustively than any other investigator, concluded that while the specific infectious agent in yellow fever had not been demonstrated, it is probable that it will be found in the alimentary canal, as in the case of cholera. He found that there are many facts relating to the origin and extension of yellow-fever epidemics which give support to the inference that the specific infectious agent is present in the dejecta of those suffering from the disease, and that accumulations of fæcal matter and of other organic material of animal origin furnish a suitable nidus for the development of the "germ," when

climatic conditions are favourable for its growth. Based on this reasoning, Dr. Sternberg suggested a method of treatment by one sixth of a grain of bichloride of mercury and seven and one half grains of sodium bicarbonate in three tablespoonfuls of ice-cold water every hour.

As has been said by an able committee of experts, the most frequent agency in the dissemination of yellow fever from place to place is found in yellow-fever patients; and more epidemics of yellow fever have resulted from the introduction into previously exempt places of persons sick of the disease, or falling sick after arrival, than from all other causes. But it is impossible to say to what extent the body, or the clothing and baggage, of the patient is responsible for an epidemic.

Yellow fever is unknown in Europe, except in Spain and Portugal, where it was carried from Brazil and the Spanish West Indies; it is also unknown in Asia and Australasia. It has affected a few localities on the west coast of Africa, while it seems to be endemic in Cuba, the Spanish West Indies, and the eastern coast of South America. It is particularly a disease of seaport cities, and it has been introduced into every seaport of the Atlantic coast of the United States as far north as Boston, and has even extended into the interior of the country along the Mississippi River as far as St. Louis, and along the railroad routes. While the disease appeared occasionally in Cuba previous to 1761, since that date it has existed there as an endemic, as was demonstrated by the Yellow Fever Commission sent there by the United States in 1878, cases occurring not only every year, but every month in the year. Vera Cruz and Rio Janeiro have for years been endemic sites for yellow fever.

In 1793 there was a severe epidemic of yellow fever in Philadelphia that Dr. Benjamin Rush attributed to putrid coffee; the mortality was ten per cent. of the gross population, although so many people (twelve thousand estimated) left the city that it is likely that the actual mortality was higher. In 1797 there was a second epidemic in Philadelphia, though the mortality was not much greater than in 1669, 1741, 1747, and 1793, which are not always classed as epidemic years notwithstanding the fact that a number of persons died of the fever.

In 1798 this fever was epidemic in New York, Philadelphia, Boston, Charleston, S. C., Wilmington, New London, and Portsmouth, the most northern point in the United States where this fever has occurred. In 1802 there was another epidemic affecting the cities above mentioned, except New York and New London as well as Baltimore. There were a number of local outbreaks of the disease subsequent to 1802, but no general prevalence occurred until 1853, when the fever was general throughout the States of Louisiana, Mississippi, Alabama, Florida, Arkansas, and Texas. In 1867 the fever prevailed extensively in Louisiana and Texas. Florida, Alabama, Mississippi, Louisiana, and Texas suffered

again in 1873. The last extensive epidemic was in 1878, when the fever existed in Alabama, Mississippi, Louisiana, and Tennessee, while there were a few cases in Kentucky, Ohio, Illinois, and Missouri.

The experience of the quarantine system in vogue at the stations conducted by the United States and the States shows that if there is proper sanitary supervision of vessels at their points of departure, and, if there is any evidence of sickness, if they are thoroughly disinfected by the sanitary authorities at the point of arrival, the germ of the disease can be excluded. It must be always remembered that yellow fever, like cholera and typhus fever, is not indigenous in the United States, and that proper quarantine precautions will exclude it. Those infected or ill with yellow fever must be isolated as far as practicable; and if the infection gains access to a town, the healthy inhabitants should be removed to camps of observation, those who subsequently become affected being at once removed to a sick camp. The excreta, clothing, and other articles that come in contact with the sick must be carefully and rigorously disinfected.

A susceptible individual should avoid infected localities, and, if this is not possible, he should not go near wharves and shipping, or dirty or infected parts of the city. He should keep regular hours, observe moderation in diet and drink, keep out of the sun during the hot portions of the day, keep the bowels regular, use baths daily, and sleep some distance above the ground. The sanitary improvement of cities may be so thoroughly carried out that yellow fever, if introduced, would be no more dangerous to the community than typhoid fever, and it would necessitate no greater or no less care.

Typhus Fever.

Typhus fever is an acute infectious disease that is characterized by a sudden onset, a spotted eruption, and marked nervous symptoms; it generally terminates by crisis about the end of the second week. It is not indigenous in the United States, and it was formerly more prevalent than it is to day, being known as hospital fever, ship fever, camp fever, or jail fever, on account of its tendency to affect people congregated in limited and unsanitary quarters. It is essentially a disease that is propagated by overcrowding, lack of cleanliness, bad food, and intemperance.

While the specific germ of this disease, which must not be confounded with typhoid fever, has not been discovered, its highly contagious character suggests that it is a germ disease. The period of incubation usually lasts a week, though it may be twelve days, during which there is a feeling of discomfort. The invasion is marked by one or more chills, followed by fever, headache, pain in the back and legs, a flushed face and congested eyes, a dry, white-furred tongue, and a dull, stupid condition. The eruption appears between the third and fifth days upon the abdomen,

upper part of the chest, extremities, and face; the rash consists of dusky, red or rose-coloured spots. There may be vomiting and retention of urine. The prostration becomes more pronounced, there may be delirium, or the patient lies in a dull, apathetic condition. Sometimes the patient lies with the eyes open but unconscious regarding his environment. When the crisis occurs at the end of the second week the patient may awake from a sleep, feeling better and clear in mind; convalescence is moderately rapid and a relapse is rare.

The mortality of the disease varies in different epidemics from ten to twenty per cent. After middle age the mortality sometimes exceeds fifty per cent., while children rarely die. The female sex seems most susceptible. The disease increases in intensity in cold weather, in consequence of the overcrowding and ill ventilation of apartments.

The affected should be isolated in barrack wards or in tents, and the apartments from which they were removed should be thoroughly disinfected.

CHAPTER XVII.

THE PREVENTION OF COMMUNICABLE DISEASES.

MEANS EMPLOYED.

General Sanitation.

PREVENTION of communicable diseases includes the collection and disposal of all filth and the abatement of nuisances which are likely to contaminate the air, drinking water, or food supplies. But thorough as the general sanitation may be, it will not suffice to restrict all these diseases if there is careless dissemination of contagion. By means of vaccination immunity may be conferred on a community against the prevalence of smallpox, and medical science is assiduously investigating the question of the prevention of those communicable diseases, but one attack of which, as a rule, occurs during life. Until this question is decided recourse must be had to *isolation* and *disinfection.*

Isolation.

Isolation may be secured by sending the patient to a hospital for communicable diseases, which is too often called a pesthouse. As a matter of course, such disease can not be treated in the wards of a general hospital, and few such institutions have detached pavilions for the reception of patients suffering with these diseases. Home isolation is often impracticable, and it is desirable that all communities should contribute to their own welfare by establishing hospitals for patients suffering with diphtheria, scarlet fever, measles,

chicken pox, variola, varioloid, and other such diseases as may happen to be prevalent.

Wherever the community is large enough to have a board of health it should be the duty of every physician to report in writing the name, age, and residence of every individual under his care suffering with one of the more important communicable diseases.

The diseases so included are, as a rule, cholera, yellow fever, small-pox, diphtheria, including membranous croup, typhus fever, typhoid fever, relapsing fever, scarlet fever, measles, and in some localities tuberculosis. Besides the foregoing, in France choleriform diseases, plague, dysentery, puerperal infections, and ophthalmia neonatorum must be reported; while in England and Wales erysipelas and continued fever are reported and several of the above-mentioned diseases are not reported. If the relatives of the affected person are unable to enforce proper isolation, then the sanitary authorities should be vested with power to remove the patient to a properly equipped hospital, where sufficient care and attention will be given to promote his recovery as well as to prevent any extension of the disease. By thus isolating the first case it is almost impossible for the disease to make any headway, because the infection may be destroyed by proper methods, and those in association with the patient can be kept under supervision until the period of incubation has passed.

When hospital isolation is undesirable or impossible the patient should be placed in a room in the top of the house, and other inmates of the dwelling should have no communication with it. The carpet, curtains, and other hangings, pictures, ornaments, and superfluous furniture should be removed, as they may retain the contagious principle for months. Proper ventilation should be secured by means of some of the measures suggested in the chapter of this article on that subject. There should be an abundance of light, because sunlight is an excellent disinfectant, the infectious agent retaining its virulence longest in a dark room. Aërial connection between the sick-room and the rest of the house should be prevented by locking all doors of exit from the room save one, and tacking outside of this one a sheet which is completely moistened with a two-and-one-half-per-cent. solution of carbolic acid in glycerin, or some other disinfectant liquid.

Nothing must be permitted to leave the room until it has been disinfected, and all dressings and rags should be burned. Soiled bedding and clothing should be placed immediately in a disinfectant solution.

If the disease is one of the contagious diseases of childhood and there are other children in the house, it is advisable, if possible, to remove the healthy children to some other house. Parents should not believe that it is necessary for a child to have any of the communicable diseases, or that

the sooner it has such a disease and "gets over it" the better. Disease is not a normal, but an abnormal state, and consequently no disease need be acquired in order to further a child's welfare; and, furthermore, it is impossible to say whether a child will get over a disease, for any of these affections of childhood may be followed by sequelæ that will affect the child's health for the balance of its life. For this latter reason it is quite essential that healthy children in a family in which one child is suffering with a communicable disease should not be allowed to go to school.

Other Preventive Measures.

Those in attendance on the sick should wear dresses made of some material that may be easily washed. They should frequently wash their hands with soap and water, subsequently rinsing them in some disinfectant solution.

All discharges from the patient should be received into a covered vessel containing a disinfectant solution, in which they are allowed to remain for ten or fifteen minutes. The discharges should not be thrown into a privy vault or cesspool, but buried at some distance from the well.

In scarlatina, diphtheria, measles, and smallpox it is better to wipe the discharges from the mouth and nostrils by Japanese paper napkins or soft tissue paper, which can be placed in a paper bag (such as grocers use) and burned. This arrangement is preferable to using rags or towels, as the paper napkins cost but a small sum per gross and their destruction is easily assured.

There should be no beating or brushing of clothing or bedding, or dusting, in the sick-room, the dust being removed daily by wiping the furniture, floor, and window sills with a cloth wet with a solution of corrosive sublimate of a strength of 1 to 1,000, or with a five-per-cent. carbolic solution. Both on account of preventing annoyance to the patient and of limiting the extension of the disease, the windows should be, in warm weather, protected by screens or mosquito netting to exclude flies.

During convalescence from smallpox, scarlatina, and measles the body should be disinfected daily by the use of warm baths, in accordance with the directions of the attending physician.

Care of Clothing, Bedding, etc.

Clothing, bedding, towels, etc., should be placed in a covered vessel containing a five-per-cent. carbolic-acid solution, and then the articles should, after prolonged immersion, be boiled or sterilized by steam. Where there is a public disinfecting plant all clothing may be sent to it.

An iron bedstead that has a woven-wire mattress is best for use in the sick-room, because one or two blankets may be folded and laid over the wire mattress instead of using a hair, cotton, or other mattress. A bed so made is very comfortable, the frame can be thoroughly disinfected, and the blankets can be sterilized more conveniently than a bulky mat-

tress. If the latter is used it should be protected by a piece of rubber sheeting that can be destroyed when the illness has terminated.

The bed linen must be kept clean, being changed as often as necessary. The person of the patient should be kept scrupulously clean; the nates must be carefully wiped with paper moistened with bichloride or carbolic solution after each evacuation; oil of sweet almonds, or some similar substance, may be applied to prevent diffusion of the scales of epidermis in some of the eruptive diseases; and in smallpox powdered lycopodium and talc may be dusted on the body. The use of baths is an essential.

Care of Instruments, etc.

All instruments, such as thermometers, tongue depressors, throat and nose tubes for syringes, etc., should be kept immersed in a carbolic solution, a piece of cotton on the bottom of the receptacle preventing likelihood of breakage of glass articles.

Dishes, spoons, forks, etc., should be boiled in a solution of bicarbonate of soda and then rinsed in pure water.

Food and liquids should not be allowed to stand in the sick-room, as they may become contaminated. Only sufficient food and drink for immediate use should be taken in at one time, and the portion unused should be thrown into a disinfecting solution.

Books, toys, papers, etc., which were used by the patient should be destroyed by burning. Toys have been known to retain contagion for months, and even years. When the patient leaves the room at the end of convalescence he should be thoroughly bathed in a carbolic solution, the hair being washed with a bichloride-of-mercury soap, or saturated with a solution of that salt, the nails cleaned, and the nose and throat irrigated, and he should put on clean clothing.

In the Event of Death.

In the event of death from a dangerous infectious disease, the body should be enveloped in a sheet wet with some strong disinfectant solution, such as a 1-to-1,000 bichloride-of-mercury solution, or a solution of six ounces of chloride of lime in a gallon of water, and then placed in a hermetically sealed coffin, or (preferably) cremated. The funeral services should be private.

Disinfection.

When the illness has terminated and the patient left the room, the latter and its contents should be disinfected. If possible, all bedding, clothing, rugs, and other fabrics should be sent to a disinfecting establishment. If this is not possible, the furniture should be covered, after taking all articles that could be boiled to the laundry of the house, and the ceiling and walls should be wiped over with a cloth wet frequently in a 1-to-1,000 corrosive-sublimate or a five-per-cent. carbolic acid solution. If the ceiling and walls are painted

they can be well cleaned in this way; if the ceiling is kalsomined it should be subsequently scraped and rekalsomined, and if the walls are papered they should be repapered. After cleaning the ceiling and walls, the window frames, windows, and floors should be carefully sponged with the same solutions. The covers may then be carefully removed from the furniture, placed in disinfecting solutions, and subsequently boiled. The furniture must be carefully and thoroughly washed with hot water and soap, all drawers being taken out and all bed slats or springs removed, and then it may be sponged over with a disinfecting solution.

Disinfectants, Antiseptics, and Deodorants.

When the word *disinfectant* is used it is intended to signify a substance which destroys infectious material; it is therefore synonymous with the terms bactericide or germicide. An *antiseptic* is an agent that arrests fermentation or putrefaction, impeding the growth but not destroying the vitality of micro-organisms. A *deodorant* is a substance that destroys or masks offensive odours, but it is not necessarily a disinfectant or even an antiseptic.

Clinical evidence has shown that the activity of most, if not of all, communicable diseases is materially impaired when the patients are freely exposed to a plentiful supply of air. Hot weather inhibits the propagation of some diseases, cold weather limits the spread of others; but the agencies of air and temperature do not always suffice, and disinfection by other means is essential.

Dry and Moist Heat: Burning.

The most efficacious means of destroying infectious material is to burn it, though necessarily the application of this measure is limited by the value of the article exposed to infection. Dry heat will destroy infectious material, but it penetrates very slowly into bedding and clothing, and it also affects the articles exposed to it. Moist heat in the form of steam or boiling water is a most valuable disinfectant that is susceptible of general application and does not injure fabrics. Steam penetrates far more rapidly than dry heat, and if it is applied under pressure it will disinfect fabrics in a short time. Portable disinfecting chambers are now made at a small cost which should be owned by every small city and town; in large cities more capacious disinfectors should be built, disinfection being obtained in such apparatus in from five to thirty minutes if the steam is superheated and under pressure. Mattresses, pillows, carpets, curtains, blankets, towels, clothing, etc., may be disinfected by steam, though it is not applicable to leather, rubber, etc. When the steam is not obtainable small fabrics should be disinfected by boiling, while carpets and mattresses may be scrubbed with a bichloride solution and then exposed to the sun for some time, though the sunlight is likely to affect the colours of the carpets.

Chemical Disinfection.

The use of certain chemicals that, in definite quantities, destroy a micro-organism and its spores is termed chemical disinfection. Koch, Sternberg, and other investigators have studied the effects of different chemicals, and the use of such agents is to-day based upon their conclusions.

Mercuric chloride or corrosive sublimate is one of the most efficacious and powerful germicides in use, although it is precipitated by albuminous substances and is exceedingly poisonous. By using an acidulated solution the coagulation of albumin may be prevented, and by colouring the liquid and using rough glass bottles its poisonous character is likely to be recalled. A solution may be made by dissolving one ounce of corrosive sublimate and two ounces of hydrochloric acid in six gallons of water, which are coloured by ten grains of aniline blue. But if fabrics are to be disinfected the aniline should be omitted. Instead of hydrochloric acid, potassium and sodium chloride in the proportion of two and a half parts of each to one of sublimate may be used to prevent coagulation of albumin.

Carbolic acid is not so readily decomposed as corrosive sublimate, and it may be used in solutions of a strength of from three to five per cent. Crude carbolic acid mixed with an equal volume of concentrated sulphuric acid and filtered is a good disinfectant for excreta.

Chloride of lime is a useful disinfectant for excreta, but not for clothing; it may be used in a solution of six ounces to a gallon of water.

A freshly prepared solution of quicklime is a valuable disinfectant for typhoid and cholera evacuations, and whitewashing rooms or buildings is an excellent measure after the presence of contagious diseases of cattle.

Permanganate of potash is a feeble disinfectant.

Sulphurous-acid gas is a useful disinfectant where there is no colour that can be injured and when there is sufficient moisture to insure penetration.

Commercial disinfectants which are advertised and sold as such are expensive, and possess no advantages over those above enumerated. Cleanliness, the free use of hot water and soap, and light and air are the most efficient and general means of disinfection.

VI.

SURGICAL INJURIES AND SURGICAL DISEASES.

By ALEXANDER B. JOHNSON, M. D.

INTRODUCTION.

SURGERY is that part of medical science which deals especially with the cure and relief of diseases and injuries by manual and mechanical means. Although surgery and internal medicine go hand in hand, and are mutually dependent one upon the other, a good surgeon must first of all be a good physician.

The Relation of Surgery to Internal Medicine.

Within the past twenty-five years many important advances have been made in our knowledge of the causes, and consequently of the treatment, of surgical diseases. At the present time there is scarcely an organ in the human body which has not been subjected to successful surgical treatment.

In the following pages the attempt will be made to instruct the reader in regard to such facts as will enable him to render prompt assistance to those who may be injured in various ways, and to know how to refrain from doing what is hurtful.

First Aid to the Injured.

Still more than this will be attempted. There are many surgical diseases, the prompt and fitting treatment of which may save the individual from speedy death, from protracted pain and invalidism, or from permanent deformity. It is the special purpose of this article to describe some of these conditions, in simple language, so that they may be recognised in time to admit of early and successful treatment.

Surgical Diseases.

Only such diseases will be described as are of common occurrence, and the recognition of which does not necessarily require professional training, or, if others are mentioned, they will not be dwelt upon at length.

The writer would prefix his statements by the assertion that there is nothing occult or mysterious in the recognition and treatment of surgical injuries or diseases, and that all the measures used are simply such as are derived from the dictates of common sense aided by the facts known to us by observation and experience.

Common Sense in Surgery.

CHAPTER I.

WOUNDS.

When the living elements of which the body is composed are suddenly torn asunder by mechanical violence, the condition thus produced is called a wound; if the overlying skin is broken, we speak of an open wound; if not, of a subcutaneous wound or contusion. An example of the former condition is the cut made by a knife; of the latter, a black eye or a black and blue spot.

Open Wounds; Contusions.

Under favourable circumstances the separated tissues are reunited by the production from the parts adjacent of sufficient new tissue to close the gap. The steps of the process may be described briefly as follows: The divided vessels contract and retract, the little round or white cells of the blood crowd about their cut ends, and, partly by mechanical and partly by chemical action, help to stop the bleeding, a most important function on their part in wounds of large size. In a few hours a soft, sticky substance, which glues the edges together, is poured out from the sides of the wound. In this sticky substance many more of the little white blood cells congregate. Soon the cells of the tissue near the wound begin to divide, each one into two, and to arrange themselves like bricks in the space to be filled. The little blood-vessels also begin to sprout and to form new hollow tubes which project in loops, and these are joined by other loops from the opposite side of the gap; then the little loops open into each other, and a bridge carrying nutriment for the growing tissue is formed. The little white cells which first entered the breach perish for the most part, and become food for the new tissue cells which come after them. Thus the deeper parts of the wound are united. Many of the new blood-vessels afterward disappear because they are not needed, and many of the new tissue cells change their shape and come to resemble the cells from which they originated.

The surface of the wound, which should be covered by new skin, is healed by the growth and multiplication of the upper layers of skin cells

at the sides of the wound. They spread from the edges to unite in the middle of the wound, like the ice which forms upon a pond in winter.

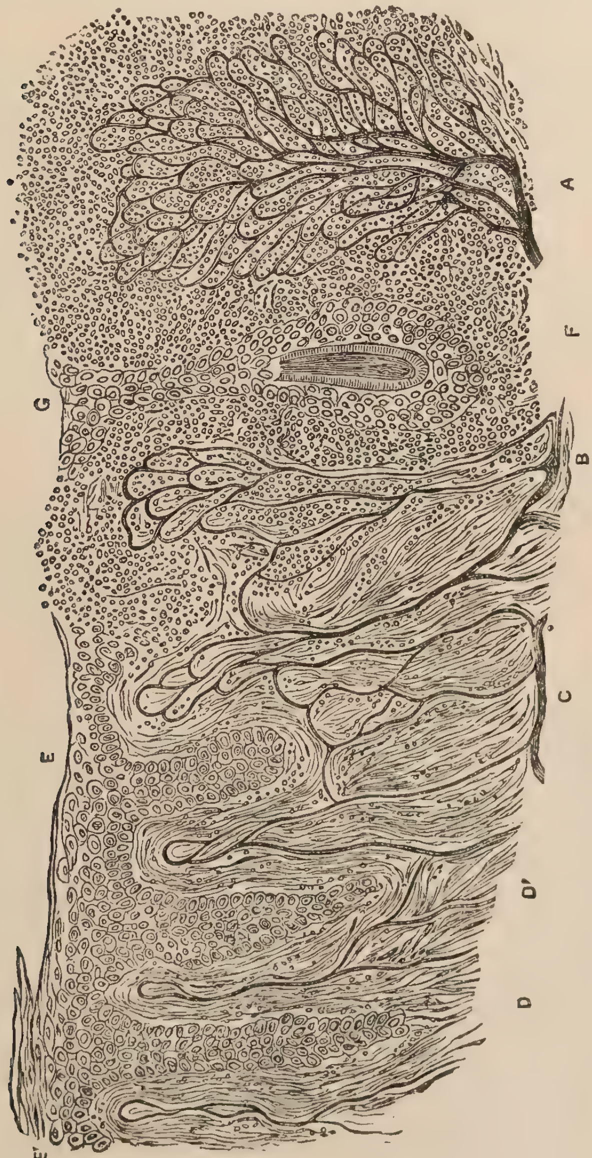


Fig. 1.—Granulating wound undergoing cicatrization. (Landerer.)

A, vessel with numerous lateral branches; granulation cells not much changed, only a few spindle cells near the main trunk; B, cicatrization further advanced; spindle cells predominate; C, D, D′, cicatrization well advanced; E, E′, epithelial cells; F, hair-follicle with proliferation of epithelial cells in its interior, new cells reaching the surface, G.

When all the surface of the wound is covered in we speak of the resulting new tissue as a scar.

Where the edges of a wound are closely in contact, healing is often complete in a week.

If the gap to be filled is not too great, many wounds of muscles, bones, glands, and some other tissues are united by new muscle, bone, gland, etc.; but if the gap is too great, or other circumstances are unfavourable, the union takes place by connective tissue merely—*i.e.*, by an ordinary scar.

When a considerable gap must be filled before a wound can heal completely, the process is carried on in precisely the same way as when the edges are in contact, but a longer time is required. The new tissue grows up from the bottom of the wound. When the cavity is filled, the skin grows over the raw surface from the old skin at the edges of the wound as before.

Scars.

The closer the contact of the edges of a wound during healing, the sooner the process is completed and the smaller the scar—a very important thing, sometimes, because scars contract with age and pull on the adjoining structures, thus producing deformities, especially near joints and openings, like the mouth and eye.

Healing by First Intention.

We have considered hitherto the healing of a wound under the most favourable circumstances. The process has gone on rapidly and continuously. There has been no pain, no redness of the skin, no fever, and only a very small amount of watery discharge from the wounded surface. The blood-vessels and tissues near the wound have produced just enough new tissue to fill the gap, and nothing has interfered with this function. *Clean wounds in healthy tissues always heal in this way.* But all wounds do not, and the reason is that often something interferes and delays and prevents the healing. When a wound becomes inflamed and painful, and does not heal rapidly, it is because bacteria are growing in it. They have been introduced usually from without, either at the time the wound was made or afterward, and this leads us to the consideration of inflammation in wounds.

THE RELATION OF BACTERIA TO THE INFLAMMATION OCCURRING IN WOUNDS.

The Omnipresence of Bacteria.

The reader will be told in another part of this volume of the relation of bacteria to certain diseases, but in no way do bacteria make their presence more distinctly manifest than in the changes which they produce when they gain access to a wound. Not all kinds of bacteria interfere with the healing of wounds, but the few kinds that do are so very abundant that practically they may be said to exist in every spot on earth which human beings are likely to visit, except on the tops of high mountains and in regions of extreme cold, and even there they are not to be got rid of, for they inhabit the surface of our bodies and all the little pockets which the skin

contains. It is safe to say that one can not touch the tip of a finger to any article of household furniture or to one's clothing without bringing away several and perhaps many of these bacteria which cause wounds to inflame.

On entering a wound the bacteria find a soil upon which they thrive, and heat and moisture, the conditions which they need for their growth and multiplication.

Warfare between Bacteria and Living Cells.

They attack the living cells, especially the white blood-cells and tissue-cells, and are in turn attacked by them. The tissues of the body make a violent effort to get rid of the invaders; the blood-vessels of the part dilate and much more blood is poured through them, carrying little white cells in abundance. They leave the vessels and do battle with the bacteria, which they inclose within themselves. Sometimes they destroy and sometimes they are destroyed. The increased amount of blood in the vessels is the cause of the redness and heat of the skin about an inflamed wound. The tissue-cells multiply and together with the white cells of the blood form a barrier to stay the advance of the bacteria. The tissue-cells kill and are killed by the bacteria. Much fluid also escapes from the blood-vessels into the tissues. In connection with the many cells crowded in the inflamed part, it causes the swelling of inflammation. The consequent pressure upon the nerves causes the pain.

Many white blood-cells and young tissue-cells appear upon the surface of the wound and escape carrying bacteria within them. They, with a watery fluid, constitute the discharge from an inflamed wound, the matter or pus. Other changes are produced by the bacteria. If their attack upon the tissue-cells succeeds and many tissue-cells are killed, a considerable area of dead tissue may be produced. This result is sometimes favoured by the overcrowding of the blood-vessels with blood-cells, resulting in a stoppage of the blood stream. When this takes place the tissue-cells are deprived of their nutriment and fall an easy prey to the bacteria. Death of the tissue results.

Poisons produced by Bacteria.

The bacteria are harmful in another way. They produce violent poisons which injure the tissues locally, and are absorbed into the system, causing fever, great weakness, headache, loss of appetite and other symptoms which are sometimes severe enough to kill the individual.

When the bacteria which cause putrefaction in dead animal matter gain access to a part of the body already dead, like a mortified limb, they produce poisonous substances which act on the body like the poisonous alkaloids (atropine, strychnine, or morphine). This condition is called *Septic Intoxication.*

When the bacteria of wound inflammation multiply in a wound or an

abscess, they also produce substances which poison the system, and the living bacteria may enter the blood current and multiply, furnishing an additional source of poison. This condition is called *Septic Infection* or *Septicæmia*.

The slight fever accompanying a boil is due to this cause as well as the most rapidly fatal form of inflammation of the bowels or peritonitis which often causes death in a few hours or days.

Pyæmia.

When the bacteria growing in a wound cause coagulation of the blood in a vein, and the bacteria-laden clot softens and portions of it are carried to distant parts by the blood stream, abscesses may be produced in remote organs. This condition is called *Pyæmia*.

Healing by Second Intention.

Usually, if the wound be not too large and the poisoning of the system not too intense, the living tissues finally triumph, the bacteria are all killed, the pain, heat, redness, swelling, and fever subside, the wound no longer discharges pus, the dead parts are separated from the living and are cast off or absorbed, and the wound heals as did the clean wound already described. The process has taken much longer, and has been attended by much suffering and often by severe illness from which the individual has but slowly recovered.

The Interference of Bacteria with Healing.

The amount of interference which bacteria cause in the healing of wounds varies much according to the number and special kind of bacteria introduced, the size and situation of the wound, and the health of the individual. A few bacteria are often killed speedily by the tissues and do no harm, but if many are present, and of a virulent character, if the tissues have been greatly bruised, if much blood lies in the wound cavity, if the wound discharge can not escape, if the health of the individual is feeble and his tissues are poorly nourished, if they be already diseased in certain ways, then the bacteria find a favourable field, and inflammation more or less severe occurs. Besides the bacteria which cause ordinary wound inflammation there are others which, when introduced into a wound, cause inflammatory diseases of special kinds. They will be alluded to in connection with these diseases.

THE SYMPTOMS OF WOUNDS.

Incised Wounds.

Wounds made with a sharp cutting instrument, or where the tissues are separated without much bruising, are called *incised wounds*. Such wounds cause pain when inflicted. The sharper the instrument, and the more rapidly the wound is made, the less the pain. Wounds of sensitive regions, like the fingers and face, cause more pain than those of less sensitive regions, like the skin of the back.

The divided tissues are elastic, and hence contract, causing the wound to gape. If a wound is made across the length of a limb it usually gapes more than when made parallel thereto. Divided muscles, especially, contract and cause the wound to gape.

Gaping.

A more important symptom of wounds is bleeding, which may take place from arteries, veins, or capillaries. *In bleeding from an artery the blood is of a bright-red colour and flows out in jets which correspond to the beating of the heart. The bleeding from veins takes place in a steady stream which wells up from the divided vein, especially from the end farthest from the heart, and the blood is of a darker colour. Bleeding from capillaries, the smallest blood-vessels, takes place by an oozing from the whole wounded surface.* The bleeding from small arteries, veins, and capillaries usually soon stops of itself by contraction and retraction of the cut ends of the little vessels and coagulation of the blood in their interior. This is Nature's method of stopping bleeding, and it is fortunate that these changes do take place, else a wound, however slight, would be fatal—a fact well shown in those persons called "bleeders," in whom, because Nature does not stop the bleeding in the way described, trifling wounds may be followed by severe or fatal hæmorrhage. When very large arteries or veins are cut—like the large vessels of the neck or the principal arteries of the limbs—death may take place from loss of blood in a few minutes.

Bleeding.

The general symptoms of severe bleeding are paleness and coldness of the face and surface of the body, especially of the extremities, rapid and feeble pulse, great and increasing weakness, spots before the eyes, noises in the ears, nausea, vomiting, giddiness, great anxiety of expression and feeling, thirst and dryness of the throat, sometimes fainting, which aids in checking the bleeding, because, in fainting, the heart pumps the blood through the vessels feebly and coagulation is favoured thereby.

Symptoms of Severe Bleeding.

The signs of a fatal termination are air-hunger, gasping for breath, convulsions, dilatation of the pupils of the eyes, unconsciousness, and the involuntary escape of the contents of the bladder and lower bowel.

The struggling for breath and convulsions are due to the same cause which produces these symptoms in strangling—*i. e.*, want of oxygen, which the blood supplies, in the brain.

The entire quantity of blood in the body is about ten per cent of the body-weight, and hence an individual weighing one hundred and fifty pounds would possess about fifteen pounds of blood. In such an individual a loss of seven pounds of blood would be surely fatal, and a loss of four pounds would be very dangerous. Very young and very old people bear loss of blood badly.

GENERAL TREATMENT AFTER GREAT LOSS OF BLOOD.

The bleeding having stopped of itself, or having been stopped according to the directions given under *The Treatment of Wounds*, certain measures are used to restore the patient's strength.

Slight Bleeding.

When bleeding has been slight and the patient has fainted from fright rather than from loss of blood, a horizontal position (no pillow under the head), the smelling of salts of ammonia or weak ammonia water, together with the administration of a tablespoonful of any strong liquor not much diluted, will usually be efficient.

Serious Bleeding.

When the bleeding has been large in amount more active measures are used. Put the patient in bed with no pillow under the head, raise the foot of the bed on a chair or on books or bricks so that the head is lower than the feet to enable the vital organs, especially the brain, to get as much blood as possible. Cover the body with warm blankets and lay hot bricks, bottles, or cans full of hot water along the limbs and trunk, protecting the skin from burning by covering the hot materials with flannel or towels. Give hot milk, coffee, or water by the mouth liberally, together with brandy or whiskey in doses of a tablespoonful, repeated every fifteen minutes, or until the pulse becomes slower and fuller and the patient's colour improves. Inject into the lower bowel, with a syringe of any kind at hand, half a pint of hot water containing two tablespoonfuls of whiskey or brandy. Large amounts of strong liquor do not produce intoxication under such circumstances.

In extreme cases the limbs may be tightly bandaged from the toes and fingers to the trunk, to drive the blood to the vital organs. Other measures are used by medical men, especially the introduction of warm water containing a small amount of common salt and carbonate of sodium into the arteries or veins, or merely beneath the skin. This treatment is of at least temporary benefit. The direct transfusion of human or other blood is dangerous and has been generally abandoned.

SHOCK.

This is a condition of more or less profound depression of the nervous system and vital forces produced by injuries. It may be present after only slight injuries in feeble persons, or absent in injuries of the gravest character in the robust. It usually follows extensive crushing injuries, such as are produced by heavy vehicles or railroad cars when they pass over the limbs, or when vital organs are seriously injured, or when multiple injuries exist.

The symptoms of shock are cold, pale and clammy skin, rapid and

feeble pulse, shallow or irregular respiration, mental apathy. Usually patients do not complain of pain and are quite insensitive to external impressions. This condition may pass into unconsciousness and death, or improvement may take place gradually after the lapse of minutes or hours. Occasionally, instead of apathy, excitement may exist, but this is more common after severe bleeding.

Symptoms of Shock.

The treatment of shock is similar to that of severe bleeding, except that there is no need of large doses of fluid unless the two conditions coexist. Friction of the limbs toward the trunk may be practised with benefit. Where possible, hypodermic injections of the one thirtieth of a grain of sulphate of strychnine, fifteen or twenty drops of tincture of digitalis, and an amount of whiskey suited to the reaction produced by the treatment, should be given. A patient should neither be disturbed nor moved more than is absolutely necessary for his safety, and no good surgeon performs any serious surgical operation until the patient has rallied, unless it be necessary in order to stop bleeding or to fulfil some other vital indication.

Treatment of Shock.

LOSS OF FUNCTION.

After any severe crushing injury to a limb it is commonly paralyzed. When muscles or tendons are cut, the parts which they should move are paralyzed as far as motion is concerned. This is especially noticeable in cuts which sever the muscles and tendons about the forearm, wrist, and hand. When nerves are cut the muscles which they supply are no longer under the control of the will and, if the cut ends are not reunited, the paralysis is permanent. Division of a nerve of sensation is followed by loss of feeling in the part supplied by that nerve.

PUNCTURED WOUNDS.

Punctured wounds are such as are produced when sharp-pointed bodies, like daggers, long splinters of wood, needles, sharp splinters of glass, or other similar substances penetrate the tissues. The depth of such a wound usually greatly exceeds its diameter. *Such wounds usually heal readily unless many bacteria are introduced with the substance which makes the wound, or unless some important organ is penetrated or some body cavity is opened and its contents wounded.* In wounds of the chest, for example, the lung may be wounded; of the head, the brain; and in wounds of the belly the intestines may be punctured. It is usually in wounds of this character that we find portions of the instrument which caused the wound left behind in the tissues. When an artery of large size is punctured, the wound of the skin may heal, but the hole in the wall of the artery may remain

False or Traumatic Aneurism.

open, and a cavity, filled with fluid blood communicating with the artery, may be formed in the limb. This condition is often very serious, and usually requires a surgical operation and the ligation of the wounded blood-vessel for its relief.

CONTUSED AND LACERATED WOUNDS.

Contused and lacerated wounds are those in which the tissues are torn, bruised, and crushed. The edges of the wound are ragged, often blue or black in colour, and quite insensitive. The deeper parts are frequently much more extensively injured than the appearance of the skin would indicate, and often some of the wounded tissues are so bruised that they die and must come away before the wound can heal. Of course the resulting loss of substance delays the cure. *Such wounds frequently do not bleed.* The largest blood-vessel may be torn and yet, by the crushing and twisting of its elastic walls, a complete obliteration of the tube takes place and no blood escapes. This is not always the case, and free bleeding may occur, especially if an artery has not been torn completely across so that it is unable to contract and retract.

Bleeding.

It is especially in wounds of this character that what we call *secondary bleeding* may take place after one or many days. Where such bleeding occurs early it may be due to the renewed force of the heart, which was depressed at the time of the injury. When the bleeding occurs later it is usually due to the separation of the dead wall of the artery which has given way, or to ulceration of the artery caused by bacteria in the wound.

Amputations.

In crushed wounds of this kind amputations are often necessary.

GUNSHOT WOUNDS.

Gunshot wounds are such as are made by hard bodies, usually bullets or shot, when projected from firearms at high velocities. Similar wounds may be caused by stones, gravel, or other materials when driven by the force of exploding gunpowder or dynamite in a blast. The injuries caused by such missiles are most varied in character. Only a few of their peculiarities can be mentioned here.

Impact of the Bullet.

They are contused and lacerated wounds. The wounded tissues are more or less disintegrated or destroyed by the extremely violent impact of the bullet. A bullet when spent may produce a bruise of greater or less severity and not break the skin. When moving more swiftly it may merely cut a groove in the skin, but usually produces a tubular wound in the tissues.

Wounds of Entrance and Exit.

The bullet may pass entirely through the body or remain imbedded in the soft parts or bone. The wound of entrance is small—about the size of the bullet. The wound of exit may be a mere slit in

the skin, or, in the case of a bullet fired from a rifle, much larger than the wound of entrance, and, if the bullet strikes a bone, it may separate into several pieces and produce several distinct wounds of the skin.

When fired at short or moderate range a large rifle bullet of soft lead produces great destruction of tissue. The wound is often of conical shape, the apex of the cone at the wound of entrance, its base at the wound of exit. The soft parts are widely destroyed and the bones mashed to a pulp, with many splinters and fissures of the bone extending to a great distance. The hard, long bullet of small calibre, such as is used by modern armies and fired with very great velocity, produces similar injuries, but its destructive effects are thought to be less than those produced by soft bullets of larger size.

Effect of Bullets fired at Short, Moderate, and Long Range.

The apparent path of a bullet through the body is often misleading, since, when the velocity is low, a bone or even softer tissues may turn the bullet from its course, so that a wound which appears to pass directly through the chest or skull may have encircled the thorax or head just beneath the skin.

A tubular bullet wound which injures no important structure often heals rapidly without inflammation, unless infected with bacteria carried in by portions of clothing or by a dirty finger or probe.

THE TREATMENT OF WOUNDS.

It is with considerable hesitation that the writer approaches this topic. To learn how to treat wounds properly is not easy, nor can it be taught in any school other than that of experience extending over a period of years.

The rules which guide a surgeon in the treatment of wounds are simplicity itself, but the application of these rules is fraught with difficulties of a practical nature which are hard for an untrained individual to overcome, and which, under certain circumstances, may be insurmountable. The writer would therefore earnestly advise his readers to leave a wound alone as far as possible and—except when a wound is of the most trivial character—to seek at once the aid of a competent surgeon.

Theory and Practice.

Unless a large artery is divided, a recumbent position with elevation of the wounded limb is usually followed by cessation of the bleeding in a few minutes. *The loss of a few tablespoonfuls of blood is of no consequence to a healthy adult.*

Emergencies.

There are, however, circumstances under which immediate action is called for and where no surgeon can be had. The following instructions are intended to enable individuals to meet such emergencies in the most intelligent manner.

RULES.

Several objects to be attained in the treatment of wounds may, for convenience, be grouped under the following heads:

I. Not to introduce into a wound substances which will interfere with its speedy healing. Among such substances may be mentioned bacteria, cobwebs, tobacco, oakum, glue, styptic cotton, sulphate-of-iron solution, or other destructive chemical. They often fail to stop the bleeding and prevent at once any chance of rapid healing.

II. To stop the bleeding.

III. In accidental wounds, to kill the bacteria which may have gained access to the wound at the time it was received, or subsequently, and to remove gross dirt and foreign bodies.

IV. To remove such tissues as may have been killed and separated from their vital attachments, such as loose splinters of bone and portions of soft tissue which are irrevocably crushed beyond the chance of living.

V. To bring the divided tissues into accurate contact and to keep them so.

VI. To provide in certain instances for the escape of the wound discharges.

VII. So to dress the wound that the wounded parts may be kept at rest, and that no bacteria can gain access to the wound while the dressing is worn.

VIII. In wounds which are already inhabited by bacteria, to get rid of the bacteria as soon as possible so that the wound may heal. In wounds where other poisons have been introduced, such as snake bites, the stings of insects, wounds from poisoned arrows, and the like, to prevent the absorption of the poison and to neutralize its effects upon the system.

IX. Certain special objects, such as the replacement of organs which have escaped from a body cavity through the wound, or occasionally the retention of the displaced organ in its unnatural position when to put it back might cost the patient his life. To this category also belongs the reduction of deformity in broken bones where a wound communicates with the fractured ends.

X. General treatment of the patient.

These comparatively simple *indications*, as they are called, have taxed, and do tax to the utmost, the skill and judgment of surgeons. And many eminent men have devoted their lives to the solution of these problems, most of them, happily, now solved.

To avoid introducing into a wound a styptic like sulphate of iron, or a substance like fine-cut tobacco, does not need special instructions, but to

avoid introducing bacteria is another matter. As the writer has previously stated, bacteria are widely distributed, and hence everything which is to come in contact with a wounded surface should be *surgically clean—i. e.*, free from the germs of inflammation.

Surgical Cleanliness.

There was an idea, formerly very prevalent among surgeons, that bacteria usually entered a wound from the air. It is now known that bacteria entering a wound from the air are comparatively few in number, and that generally they may be disregarded as a source of wound infection.

The sources of infection which especially claim our attention are: *The hands of the person who dresses the wound, the materials used to clean the wounded surface and the dressings which are to be applied, the instruments to be employed, the water with which the wound is washed, the skin of the patient, and the wound itself, if the last be accidental.*

Sources of Infection.

To accomplish the removal and destruction of bacteria several means may be adopted. They are partly mechanical, like washing the skin and instruments with soap and water and scrubbing with a brush; partly chemical, as the use of substances, called antiseptics, which are poisons to bacteria and kill them or prevent their growth. *Bacteria are also destroyed by exposing them to a high temperature.* The ordinary bacteria of wound inflammation are killed in a few minutes by immersion in water at a temperature a good deal lower than boiling. Boiling water (212° Fahr.) kills them almost instantly. When exposed to dry heat a higher temperature is required and a longer time, and this method has but few practical applications in surgery. Steam at a boiling temperature acts less promptly than boiling water, but is efficient. Cotton, bandages, towels, and the dressings which are to be placed in or upon the wound are usually freed from living bacteria in this way by surgeons at the present time, but a special apparatus is required for the purpose, so that in this article we shall be obliged to confine ourselves to other methods.

The Removal and Destruction of Bacteria.

So to treat a wound that all, or nearly all, the bacteria may be excluded therefrom may be possible in a well-ordered hospital, and even in a private house or in a surgeon's office, where all the necessary appliances are at hand and the surgeon is possessed of the requisite skill. But in emergencies this can not be accomplished, and we must be content with very imperfect measures in treating wounds under such circumstances; still, Nature is very kind, and a good many bacteria may exist in a wound without seriously interfering with the healing, because, as we have said, the healthy tissues can dispose of the germs of inflammation when they are not too numerous.

The Total Exclusion of Bacteria Impossible in Emergencies.

Of all the ways in which bacteria gain access to a wound, perhaps none is more frequent than through the medium of a dirty finger, and many a patient has lost his life at the hands of an ignorant or a careless practitioner who has explored a clean wound with a bacteria-laden digit. Therefore, *do not touch a wound until you have washed your hands.* The hands may be rendered moderately clean in the following way:

HOW TO WASH THE HANDS.

Roll up your sleeves to the elbow; wet the hands and forearms in hot water; rub soap in thoroughly (preferably soft or potash soap), especially into the creases beneath the nails. Get up a good lather, and then scrub the hands and arms thoroughly with a stiff brush, particularly the ends and sides of the fingers and beneath the nails, and keep it up for at least three minutes. Wash off the soap in clean water, clean the nails with a bone nail-cleaner or a small piece of wood, then scrub the fingers again with a brush and soap, and, lastly, wash the hands and arms thoroughly in water which has been boiled.

If time presses, or you have no other means at hand, you may then proceed to handle the wound; but if any of the following substances are obtainable and the case is not urgent, you had better further clean the hands by immersing them for several minutes in one of these solutions:

Corrosive sublimate—one part to one thousand parts of water. Tablets of this substance can be obtained at any drug store, of such size that one tablet dissolved in a pint of water makes a solution of the above strength. This solution is very poisonous when taken internally, but harmless when used in this way.

Oxalic acid—a double handful to a quart of water. After using this, rinse the hands in boiled water, which stops the smarting of the skin that oxalic acid sometimes causes.

Strong alcohol.

Permanganate of potash—a handful to a quart of water. The stain can be removed at once with oxalic acid.

Carbolic acid—in the strength of one part to twenty or thirty of water; but carbolic acid in solutions of this strength is but a feeble germicide, is painful to the hands and very irritating to a fresh wound, and is scarcely of more advantage than plain boiled water.

Corrosive Sublimate.

Of all these substances, corrosive sublimate is the easiest to obtain and is by far the most powerful germicide. In unboiled water the germs of ordinary wound inflammation are all killed in from fifteen to twenty minutes when the solution is of the strength of 1 to 1,000—*i. e.*, seven grains and a half to the pint. Where boiled water is not to be had this substance is of great value for cleansing the hands and the skin of the patient and the wound

itself. Although corrosive sublimate does have a certain destructive influence upon freshly wounded surfaces, yet as a rule this is not great enough to interfere with healing.

By the time the hands have been cleaned in one of these ways, the bleeding, if the wound be slight, will probably have ceased, unless the patient has been running about excited by fear, or has held the wounded part under a running water-tap so that the clot has been washed away as fast as it formed.

We will suppose that the patient has lain down and kept quiet and has elevated the wounded limb, if it be a limb that is wounded, and that the bleeding still goes on.

What is the quickest and surest way to stop it?

HOW TO STOP BLEEDING.

The Pressure of a Finger the Best Temporary Device to Stop Bleeding.

Here the carefully cleaned finger is of use, and the writer wishes to emphasize one fact which, if the reader will only remember and put into practice when called upon to stop bleeding, may save a life which must otherwise be lost. Better than tourniquets, bandages, pads, or any other device to stop bleeding at once and absolutely, is the pressure of a finger directly upon the point that bleeds. This is true no matter how large the cut vessel may be. If there be more than one bleeding vessel, two or more fingers may be used, or the finger may be changed if tired. The pressure should be made against a bone, if possible, and need not be very forcible. *Moderate pressure is enough.* This method is applicable to any region of the body which may be reached with a finger or the hand. It is true that the pressure can not be kept up indefinitely, but if it be constant, this alone may be sufficient permanently to stop the bleeding from a vessel of considerable size in ten or fifteen minutes. Under most circumstances pressure can be kept up at least long enough, by changing the finger from time to time, for skilled help to arrive.

How to Apply a Tampon to a Wound.

There are other means of applying pressure for the arrest of bleeding; one of the best is called a *tampon.* To apply a tampon to a wound it is necessary to have some clean cheese cloth, or cotton cloth (muslin), or gauze, or any thin fabric which can be torn into strips a foot and a half long. If obtainable, *the antiseptic corrosive-sublimate gauze on sale at every drug store should be used.* Hereafter it will be understood that, unless otherwise stated, where "gauze" is mentioned this antiseptic gauze is meant. If antiseptic gauze is not to be had, tear any cotton fabric into strips an inch wide and eighteen inches long (gauze should be cut with a scissors). Gauze may be used without further preparation.

Other materials should, if possible, be disinfected by soaking in corrosive-sublimate solution, which is subsequently to be squeezed out in a clean hand, or the strips may be dropped into a teakettle of boiling water and boiled for two minutes. When boiled, the strips should be removed from the kettle with a clean stick or a pair of shears. When cool enough, they should be squeezed as dry as possible. If no corrosive sublimate and no teakettle is at hand, use a clean dry handkerchief torn into strips.

Lay the strips down on a clean towel.

Be sure again that your fingers are clean.

Dig out the clots from the wounds with your forefinger and try to see where the blood comes from. Take one of the strips, an end in either hand, push one end down on to the bleeding point and pack in the rest of the strip on top of it, feeding it into the wound with one hand while you pack with the other. Pack it in hard. After it is all in, keep up the pressure with one finger and pack in another strip over the first. Continue this until the wound is filled to the level of the skin and above it. Then make a pad of gauze or cloth, cleaned in the way described for the strips, and a little larger than the wound. It may have the thickness of a folded handkerchief. Lay it over the packing in the wound. Over this put a larger pad and then another still larger. Now bind the pads firmly in place with any sort of a bandage—or a pair of suspenders, if need be. This procedure will stop bleeding, permanently as a rule, from any but a very large artery in loose tissues, and is not infrequently used by surgeons in situations where it is difficult or impossible to apply a catgut ligature directly to the vessel.

Cleanliness and Freedom from Bacteria the Chief Requisites.

It is of the utmost importance that the wound and the packing should be clean and free from bacteria, and the patient should be seen by a surgeon as soon as possible. If no such aid is to be had, the packing should be removed very gently (without wetting), at the end of forty-eight hours and replaced by fresh packing, if the bleeding recurs, in which event it may be left in place for forty-eight hours more, when the vessels usually will have closed. If the bleeding does not recur and there is no pain, swelling, or redness about the wound, apply a dressing of gauze over the wound, leaving out the packing. Keep it in place with a bandage. Then leave it alone for a week, as long as there is no pain, or bleeding, or soiling of the dressing with wound discharge. This method of stopping bleeding has its disadvantages. Unless very carefully applied, bacteria will be introduced, the wound will inflame, and healing will be delayed. Therefore *do not use it unless the bleeding is severe.*

The Value of a Firm Pad of Gauze.

When bleeding is only moderate in amount and occurs from small arteries or large veins just beneath the skin, like those one sees beneath the skin of a man's forearm, or from any vessel not very deeply situated, it can almost always be stopped permanently by a firm pad of gauze bound over the wound with a bandage. The wound should be cleaned properly according to directions to be given later, and a pad applied directly over it. This first pad should be larger than the wound. Over it a number of layers of gauze should be bound. The gauze should cover a large area of skin around the wound and enough should be used so that no blood appears on the outside. If not applied very tightly, such a dressing may be left in place for a week—unless there is pain or the discharge soaks through and appears as a stain on the outside.

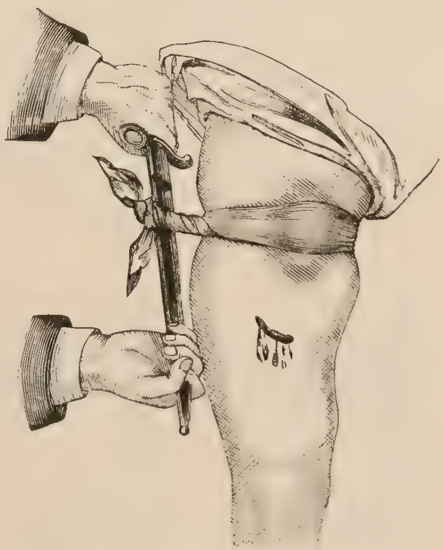


Fig. 2.—Application of an improvised tourniquet to the femoral artery.

If the bleeding has ceased only after a very tight dressing of this kind has been applied, so tight as to cause pain or swelling and blueness of the skin below the dressing, then the outside or constricting bandage alone should be removed after four or five hours and replaced by one less tight, because this swelling and blueness may indicate that the circulation of blood in the limb is being interfered with by the constriction. It is, however, quite impossible to lay down hard-and-fast rules in such matters. Skill and judgment, bred of experience, are, in practice, the only guides.

Bleeding from a Limb.

Bleeding from a limb may be arrested temporarily by compressing the main artery against the bone at a point above the wound—*i. e.*, between the wound and the heart. This may be done with the fingers or with an improvised tourniquet.

A Tourniquet.

A tourniquet is a bandage, handkerchief, or strap of webbing, into the middle of which a stone, a potato, a small block of wood or any hard, smooth body is tied. The band is tied loosely about the limb, the hard body is held over the artery to be constricted, and a stick is inserted beneath the band on the opposite side of the limb and used to twist the band in such a way that the limb is

tightly constricted thereby, and the hard body thus made to compress the artery. (See Fig. 2.)

The directions for applying pressure to special vessels will be given under *Wounds of Special Regions.*

The entire circumference of a limb may be constricted by any sort of elastic band or rubber tube.

The Elastic Constrictor.

The band or tube is passed around the limb several times on the stretch, drawn tight and tied in a knot. In this way bleeding may be stopped at once from the largest arteries. Such a band may be improvised from the ordinary rubber tubes used to convey illuminating gas to a gas-stove, or any other strong elastic material may be used. The larger and softer the tube the better. The smaller the tube the more it will bruise the tissues and hurt. It may be put around the middle of the leg for wounds of the foot, around the middle of the thigh for wounds below that point. Twice around the upper part of the thigh close to the body, crossed in front and then around the waist, for wounds of the upper part of the thigh. It may be put on the arm anywhere except just at the elbow, and to stop bleeding from the upper arm, under the arm-pit and over the shoulder. It is very dangerous to leave such a band in place for more than two hours, since the limb may subsequently die in consequence; but to leave it on a half hour or an hour is not dangerous. Draw the tube tight enough to stop the bleeding, and no tighter. The elastic tube or band has the advantage that it requires no skill and but little knowledge of anatomy to apply it efficiently. (See Fig. 3.)

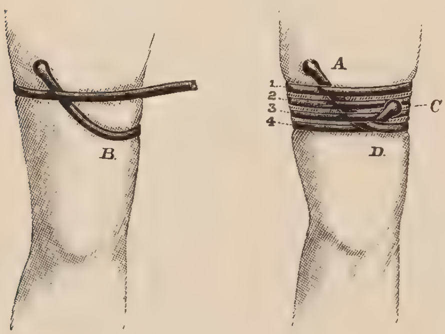


FIG. 3.—SCHAPP'S TOURNIQUET.

Bleeding from Small Vessels.

General oozing of blood from small vessels may be stopped by the application of cold or heat. Cold may be applied by pouring ice-water into a wound, or by putting ice directly on the bleeding surface. Cold acts by contracting the walls of the blood-vessels. Hot water, at a temperature of 120° to 125° Fahr. (as hot as the tip of the elbow will bear without great discomfort), acts by contracting the walls of the vessels and hastening the coagulation of the blood. *Heat and cold are inferior to direct pressure where it can be applied.* In inaccessible regions, like the nasal cavity, the vagina, the rectum, the bladder, cold, especially, is of use; in oozing from large superficial surfaces, heat.

It remains to speak of the method of the ligature, of styptics, and of the cauterization of bleeding surfaces with a piece of metal heated to a dull red heat.

Ligatures, Styptics, and Cauterization.

To stop the bleeding from arteries and veins surgeons depend chiefly upon applying *ligatures of catgut* to the ends of the divided vessel. The catgut is rendered sterile—*i. e.*, free from bacteria, by boiling it in alcohol, or by soaking it in antiseptics, or by both of these procedures. This is the best way to stop bleeding. Unfortunately, to apply it requires special instruments and special training, hence it can hardly be of use in emergencies when no medical man is by. It is practically the only method which will surely and permanently stop bleeding from a large artery. The end of the divided vessel is caught with a forceps and pinched, a strand of catgut is tied rather tightly around the vessel beyond the forceps, the forceps is then removed and the ends of the catgut cut off close to the knot, which remains in the wound and is absorbed.

Styptics are substances which, when applied to a wound, cause coagulation and destruction of the tissues, and sometimes arrest of bleeding. They often fail to stop hæmorrhage, and the last condition of that wound is worse, much worse, than the first. Any one who has seen a large wound treated in this way is not likely to try it on himself or his friends. The healing is delayed, and inflammation, blood-poisoning, and tedious convalescence are among the usual results of this form of treatment. The use of styptics is to be condemned.

The cauterization of wounds with a hot iron is an old and effective way of stopping bleeding. It is used under certain circumstances by surgeons, and may be applicable to the early treatment of the bites of rabid animals. It causes death of the tissues and delays healing, and is not to be advised in the treatment of accidental wounds.

THE CLEANING OF FRESH WOUNDS.

Bacteria and Foreign Bodies in Accidental Wounds.

In all accidental wounds some bacteria are pretty sure to be present, and in many cases foreign bodies of various kinds are either lying in the wound or embedded in the tissues. For example, gravel, coal-dust, splinters of wood or iron, grease, and ordinary soil may be ground into the raw surface, or very likely some one has wrapped a soiled handkerchief or towel about the wounded limb, or applied chewing tobacco, a piece of salt pork, the skin of an eel, or glue to the wound. It will now be necessary to consider what measures may be used to free the wound from these impurities.

We have hitherto been occupied with wounds where the bleeding has

been so severe that other considerations have been subordinated to this one; but let us suppose that the wound does not bleed much, or that an elastic band or a rubber tube has been applied and that the bleeding has ceased. Before examining the wound it is well to have everything ready and near at hand that is likely to be used in its treatment. This includes at least soap and water and, if possible, boiled water so hot that you can just keep the hand in it. It should be in several clean vessels, preferably the vessels in which it was boiled. To one of these vessels may be added some corrosive sublimate tablets—as many as will produce a solution of 1 to 1,000. Do not make it stronger.

Preparations for the Treatment of Wounds.

Alcohol or ether is useful, and also oil of turpentine, the last for cleaning very dirty skins, like the grimy hands of a machinist. Any or all of these things are cleansing.

A scissors of any kind made fast to a string and dropped into the boiling teakettle for two or three minutes is usually the only instrument necessary.

Several towels, which have been in boiling water for a minute or two or have been wrung out after being thoroughly wet in corrosive-sublimate solution, are useful, especially for spreading out on the table so that other clean things may be laid down upon them.

If gauze is obtainable, use this for the dressing; and if you have no absorbent cotton, pieces of gauze may be used to wipe the skin and the wound. If you have neither, use clean handkerchiefs boiled in water or wet with corrosive sublimate, or, if these conditions are not to be obtained, use clean handkerchiefs dry or any other clean cotton cloth. *It is better to use no dressing at all than a visibly soiled cloth of any kind.*

Bandages may be torn from a clean sheet. The method of applying them will be spoken of hereafter.

If you have absorbent cotton, tear or cut it into masses the size of a small orange, and immerse a dozen of these masses in the corrosive sublimate, or, if not in that, in the boiled water. If in neither, use it dry, unless it is visibly soiled or has been long exposed to dust. In that case you had better get along without it.

Arrange everything on a table, and put the bandages, gauze, cotton, or whatever is to come into contact with the wound, on one of the clean towels. Wash your hands as before described.

The neighbourhood of the wound should be bare of clothing for some distance.

If the wound is clean-cut and not visibly soiled, cover it with a pad of cotton or gauze, and while the pad is held in place, wash the surrounding skin over a wide area with hot water and soap. Wash off the

soapsuds with boiled water. Remove the pad and douche the wound thoroughly with boiled water or corrosive-sublimate solution, holding the edges widely apart so that the fluid can reach every portion of the wounded surface. If bleeding has been started as a result of your manipulations, press a pad of cotton or gauze firmly and steadily upon the surface from which the blood comes. Keep up the pressure for two or three minutes, or longer if necessary. As soon as the bleeding has ceased, wipe away the blood and wet from the surrounding skin with a clean towel and apply a dressing at once.

How to Dress a Clean Wound.

Suppose that instead of a clean-cut wound the injury is ragged and bruised and full of grease and coal-dust, that a filthy handkerchief has been placed upon it, and that the patient's skin is grimy. Get everything ready as before. Scrub the skin and the wound itself with soap and water, and do it thoroughly. Rub the skin around the wound with cotton wet with oil of turpentine, if you have it. Many bacteria and much dirt will be removed by this means. Then clean out the wound itself with cotton wet with ether and then with alcohol, if you have them; if not, with corrosive sublimate, or, failing that, with boiled water. Wipe it out to the bottom and search for every pocket, and diligently apply the wet pads of cotton until every portion of the wound is as clean as perseverance can make it. Cut away loose fragments of tissue which are evidently dead, with the scissors, and pick out foreign bodies with your fingers. Finally, wash out the whole wound with corrosive sublimate or with boiled water. Dry it with clean gauze or cotton, fill the cavity with gauze or other clean material, leave the wound wide open, so that all discharges can escape, and put on a dressing.

How to Dress a Soiled Wound.

If the wound is on the hairy scalp, first cut off the hair with the scissors, or, if you have a razor, shave it two inches away from the wound all around, and then proceed as in the case of other wounds.

It will occur to most people that the above treatment might be a little painful, and that it would be the part of wisdom to select rather a feeble-bodied patient for measures of this character—preferably an enemy. It certainly does require self-control on the part of the patient, and the courage of his convictions on the part of the would-be surgeon; but it is the best means of getting a dirty wound clean, and though it hurts at the time, it will save much suffering in the future.

TREATMENT OF GUNSHOT WOUNDS.

Do not probe a bullet wound. Do not put your finger in it, unless it be necessary to stop bleeding. Clean the orifice of the wound and the

skin in the neighbourhood. *Stop the bleeding by pressure, and send for a surgeon as soon as possible.*

TREATMENT OF PUNCTURED WOUNDS.

The safest treatment for a punctured wound at unskilled hands is to wash thoroughly and disinfect the skin of the part, to withdraw with the fingers, if within easy reach, any portion of the instrument which may be left in the wound, enlarging the wound with a scissors, if necessary, in order to make its extraction more easy. Apply a dressing of gauze or other clean material. (Some exceptions will be mentioned under *Punctured Wounds of Special Regions.*)

Antiseptics can not take the Place of Cleanliness.

Of wound treatment in general it may be said: *Depend chiefly upon soap and water to make things clean.* It is a mistake to suppose that even the strongest antiseptics can take the place of cleanliness. Do not think that by dipping your hands in a solution of corrosive sublimate you can disinfect them and handle a fresh wound without risk. They must be washed and scrubbed in soap and water first. There is much oil upon the human skin which protects the bacteria from the action of most antiseptics. Soap and water removes the oil and gives the antiseptic a chance to act.

Before applying a dressing to a wound, wipe away all the blood from the part and dry it with a clean towel. When called upon to treat a wound remember that *a little blood makes a great showing*, and that the accidental division of a large artery is a comparatively rare accident, and that a healthy adult can lose a pint of blood without serious danger.

Do not lose your head.

Wash your hands, if you possibly can, before touching a wound. It may be necessary to disregard this advice, but the instances will be rare. After having got your hands clean, do not touch your own or the patient's clothing, or any article of furniture and then put your fingers into the wound. First wash your hands again. Try to have everything ready at hand, so that after you have begun to clean the wound your measures may not be interrupted and your hands contaminated by handling any unclean thing.

You can not make a fresh clean wound heal any more rapidly by applying to its surface any substance whatsoever. *Nature takes care of the healing;* all that we can do is to try and get rid of such bacteria as may have gained entrance into the wound, and to keep them from entering while healing is going on. Therefore do not apply to a fresh wound any substance because you are told that it is good for the wound, that it will make it heal. Those who make such assertions are misinformed.

Do not put sticking plaster or court plaster upon a fresh wound, however small. Such materials almost always contain bacteria and will be likely to infect the wound.

Sticking Plaster.

Above all things, *do not poultice a wound to draw out the inflammation.* The materials from which poultices are made always contain bacteria, and the heat and moisture supply the conditions best suited to their growth and development. And the poultice itself furnishes an ideal soil for the germs of inflammation to grow in. If the wound is clean, there will be no inflammation, and if it is inflamed, a poultice is the very worst application possible, for reasons to be given hereafter.

Poultices.

Having once dressed a wound, its edges having been left in contact, do not be in a hurry to dress it again. As long as there is no pain, no staining of the dressings with wound discharge, no bad odour, and the outside of the dressing has not been contaminated by wet or filth of any kind, you may feel sure that the wound is doing well. If you take off the dressing you may infect the wound with bacteria.

Do not cover the dressing of a clean wound with oiled silk or other impervious material. It is better that the dressing should be as dry as possible, and the oiled silk favours the accumulation of moisture.

Oiled Silk.

Do not be afraid of "catching cold" in a wound. Such a condition is not recognised by medical men. It is not cold, but bacteria, which causes wounds to inflame.

"Catching Cold."

To bring the edges of a clean wound into accurate contact is a great advantage. It helps to stop the bleeding; it puts the surfaces into the most favourable position for union and assists the tissues to get rid of the bacteria. *Wounds are ordinarily closed by sewing the edges together with a needle and thread,* and there is no efficient substitute for this means. The necessary manipulations are not difficult. But to decide in a given case whether a wound should be closed or left open requires special knowledge and trained judgment, and the question is one which often calls for the widest experience in order to answer it correctly. The writer would therefore advise that no attempt be made to close any wound beyond what may be done by arranging the edges with the fingers or by compresses of gauze applied over it.

MATERIALS USED FOR DRESSING FRESH WOUNDS AND HOW TO APPLY THEM.

Use corrosive-sublimate gauze such as is sold at the apothecaries', if you can get it. Put on plenty of it. Shake out a large piece, crumple it up into a loose mass and lay it on the wound. Then cover the skin all around the wound with more gauze. Cover the whole circumference

of the limb with thick pads of this material, extending for a long distance above and below the wound—for instance, in a wound of the forearm near its middle, cover the limb with gauze thickly from the elbow to the wrist. Fasten it on with a bandage firmly. The dressing should not slip. It should be comfortable. It should be put on in the position which the limb is to retain after the dressing is complete.

If you can not procure antiseptic gauze, use plain white cheese cloth, or any other loosely woven cotton material finished without sizing, or from which the sizing has been removed by boiling in a solution of washing-soda. Whatever material is used, it must be of such a nature that the discharges from the wound are readily soaked up into the dressing. Fabrics containing sizing are not fit for this purpose. The soda must be removed by washing in clean water. Soak the material in corrosive sublimate and wring it out, or boil the material for five or ten minutes in water; wring it out when cool enough and apply.

Freshly laundered handkerchiefs and towels, especially if boiled and not exposed to dust, may be quite free from bacteria, and would then furnish a good material for dressing wounds. They should be used in the same way as gauze. A towel and a handkerchief taken at random from the writer's bureau, and carefully examined at the laboratory of the College of Physicians and Surgeons of Columbia University by Dr. R. G. Freeman, were found to be practically free from bacteria. Both articles had been boiled in soapsuds and had been rinsed in cold Croton water and ironed.

BANDAGES AND BANDAGING.

Functions of Bandages.

Bandages are pieces of cloth, usually cotton, of various sizes and shapes which are used for the following purposes: To exercise firm and even pressure upon a part and thereby to hold wound dressings in place; to stop bleeding; to keep the part immovable and at rest; to prevent swelling and accumulation of blood in the veins of a limb; to hold splints of various kinds in place.

A well-applied bandage should fulfil these requirements more or less perfectly. It should not slip or become loose. It should not be put on so tightly as to interfere with the circulation of a limb.

Roller Bandages.

The so-called roller bandages—long narrow strips of cloth made into a roll—are the best, and are commonly used by surgeons.

Triangular or Oblong Bandages.

Pieces of cloth of triangular or oblong shape are usually easier to obtain in emergencies, and are sometimes used as a substitute; but in many instances they fail to fulfil the requirements and are hardly to be recommended in the treatment of wounds where a roller bandage may be made or obtained. The *triangular bandage* of Esmarch may be applied to any region of the

body and, where no roller bandage is to be had, it may be used to advantage. It consists of a triangular piece of muslin of the shape shown in Fig. 4. The size may be varied according to the part of the body for which the bandage is intended.

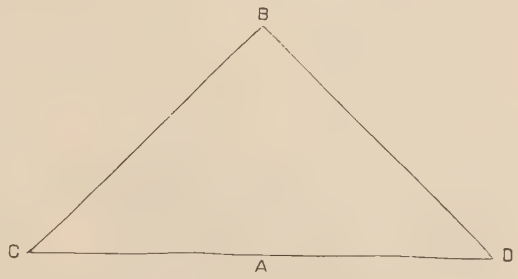


Fig. 4.—Esmarch's triangular bandage.
A, base; B, apex; C, D, basal ends.

To cover a dressing on the crown of the head the bandage may be applied as follows: Lay the base along the forehead, its edge parallel to the eyebrows. Allow the apex to hang down the back of the neck. Carry the ends back of the head, cross them below the bony bump which exists in this region, bring them forward and tie them in a square knot on the

Fig. 5.—Triangular bandage applied as a sling and as a retentive bandage to various regions.

forehead. Bring up the apex from behind and pin it to the bandage on top of the head.

Folded into a cravat, this bandage may be applied circularly or in a figure of 8 to the head or to the trunk and limbs. The ends may be pinned or tied in a knot. Fig. 5 illustrates the application of this bandage to various parts. The figure explains itself.

Roller bandages are, as stated, long, narrow strips of cloth; loosely woven cambric, unbleached muslin, and, for certain purposes, flannel are the materials from which they are commonly made; but any fabric which is not too thick may be substituted. Their width varies from one inch for fingers and toes, to four and a half inches or more for the thigh and trunk. Their length is commonly from eight to twelve yards. These bandages may be rolled by hand as follows: Tear the cloth into strips of the desired width. Beginning at one end, fold the cloth into a cylinder for eight inches and continue the process by holding the ends of the cylinder between the thumb and forefinger of the right hand, allowing the unrolled part of the bandage to hang over the back of the left hand between the forefinger and thumb. Now, by rotating the cylinder held in the right hand and guiding the free part with the left hand, the edges of the cylinder may be kept even and the bandage rolled tightly (see Fig. 6). A bandage can not be applied nicely unless it is rolled very tight, and for this reason *machine-made bandages are better* in every way and should be used where obtainable.

Rolling a Bandage by Hand.

FIG. 6.—ROLLING A BANDAGE BY HAND.

In applying a roller bandage to a limb, always begin at the point farthest away from the trunk and bandage toward the trunk. Apply the outside of the bandage to the limb. Hold the roll in the palm of one hand, the end of the bandage in the other. Apply the end of the bandage to the limb and take two turns around the limb with the roll, including the end in the turns so that it will not slip. Keep the hand which holds the roll as close as possible to the limb all the time. Otherwise you can not apply the bandage properly. As the roll passes behind the limb it may be changed from hand to hand, and again it may be changed in like manner when it passes across the front of the limb.

How to Apply a Bandage to a Limb.

Try to keep up an even tension on the bandage.

It is better for an unskilled person not to try to follow any set rules for the application of bandages, but simply to roll the bandage on, fol-

lowing the natural direction which the bandage takes, so that the turns will lie flat. This advice will be understood better when you come to apply a bandage. A symmetrical appearance of the turns is of no consequence. Simply try to put the bandage on so that it covers every part of the dressing and a little more—*i. e.*, begin the bandage below the point to which the dressing which is next the wound extends and carry it up to a point above the upper limit of the same.

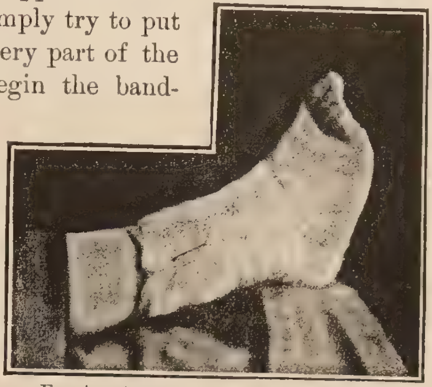


FIG. 7.—ANTISEPTIC DRESSING APPLIED.

The Spiral Method.

There are several ways of applying a bandage to a limb. It may be rolled about the part in a spiral, each turn overlapping the one below it for a short distance. This is called the *spiral method*, and is applicable when there is no marked increase in the size of the limb from below upward (see Fig. 8).

The figure-of-8 method is more generally applicable. It makes the firmest and most durable bandage, and, when properly applied, does not

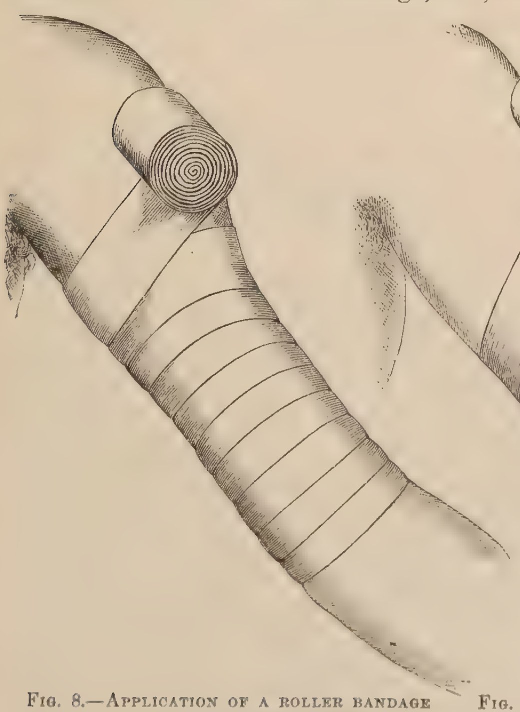


FIG. 8.—APPLICATION OF A ROLLER BANDAGE TO THE ARM BY THE SPIRAL METHOD.

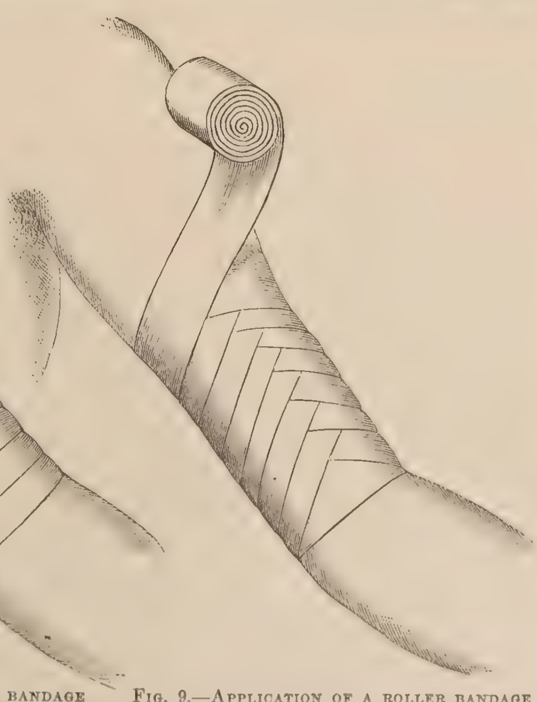


FIG. 9.—APPLICATION OF A ROLLER BANDAGE TO THE ARM BY THE FIGURE-OF-8 METHOD.

slip or get loose. The method of application is shown in Fig. 9. The bandage is begun by a few circular turns, and is then passed obliquely up and across the front of the limb, then straight across behind the limb, and then obliquely down across the front of the limb, cutting the first oblique turn at right angles. By similar turns the limb is covered from below upwards, each turn overlapping the preceding one one quarter or one third the width of the bandage.

The Figure-of-8 Method.

A modification (see Fig. 9) of the figure-of-8 method is applicable to most joints and to the junction of the limbs with the trunk. In the latter case the bandage is called a *spica*. Its application is shown in Fig. 10.

Fig. 10.—Spica bandage applied to the shoulder.

The Spica Bandage.

The writer believes that bandaging can not be learned from printed instructions. It is not an intellectual process, but a practical art. He would therefore urge upon such of his readers as wish to learn how to bandage, or who are likely to be placed under circumstances where such knowledge will be of use, to take a few lessons from some one who knows how. In that way sufficient skill can be acquired in a short time to meet any emergency of this character which is likely to arise.

INFLAMED WOUNDS AND THEIR TREATMENT.

When wounded tissues are already inhabited by the bacteria of inflammation, we speak of them as inflamed wounds.

At present we shall confine ourselves to the consideration of the forms of inflammation which are caused by the so-called "pyogenic bacteria"—*i. e.*, the bacteria which, by their growth and multiplication in the tissues, cause the formation of pus or matter. There are several varieties of these bacteria, but the action of all of them is similar and a special description of each kind is needless.

Pyogenic Bacteria.

When a fresh wound becomes infected with these germs a very varied series of symptoms may be produced. At times, the interference with healing is slight, and again, from apparently a precisely similar kind of infection, a progressive inflammation of the tissues may be caused, attended with such severe symptoms of poisoning of the entire system that death is a matter of a few days. We do not know exactly why this is so, but some of the factors which help the bacteria in their

Varied Symptoms resulting from Infection by Pyogenic Bacteria.

attacks upon the tissues have already been mentioned. Sometimes the inflammation may be confined to the immediate neighbourhood of the wound. There may be only a moderate amount of pain, heat, redness, and swelling, and a moderate discharge of pus.

At other times, the poisons generated by the bacteria, and the bacteria themselves, are taken up by the lymphatic vessels of the part and find their way to the adjoining set of lymphatic glands, where they cause inflammation in these structures and often abscesses. When such is the case, one sees red, inflamed lines on the skin, passing from the wound to the lymphatic glands. The glands themselves become swollen and tender. The patient usually has fever and other symptoms of illness. The action of the lymphatic glands, under such circumstances, is a protective one, because the bacteria usually can not pass the inflamed gland, which acts like a kind of filter, and, while the gland itself may be destroyed, the system at large may suffer but little.

Abscesses.

At other times, when the discharge has no adequate avenue of escape, serious changes are produced. The matter accumulates in the deeper parts of the wound and soon the increasing tension causes it to burrow into the surrounding tissues, and abscesses of greater or less extent may be formed, which continue to grow until the matter either finds an outlet by destroying the overlying tissues and finally the skin, or until an outlet is made by the surgeon's knife. Under such circumstances, one finds usually present great pain and severe constitutional symptoms which may end in death if the abscess is not opened with the knife. Often this relief is afforded too late. In these cases much tissue is often destroyed, and tedious healing and crippled limbs are a frequent consequence of such inflammations.

Progredient or Progressive Septic Phlegmon.

In injuries, especially where much bruising of the tissues has occurred, and occasionally in clean-cut wounds, quite a different train of events takes place. The inflamed wound does not discharge much matter, only a little watery, bloody fluid ; but the tissues rapidly die, and this local death spreads beneath the skin, so that in a few days the whole limb may be involved in the process. There is no bad odour, no gangrene properly so called, but an enormously rapid spreading of the bacteria in the tissues which are killed without undergoing putrefaction.

If life is prolonged, the dead tissues soften and large collections of matter are formed beneath the skin and between the muscles and sometimes in the joints. The skin itself may be involved in the process from the first. It then appears dark red in colour, and hard or doughy to the feel, and, if the tension be not relieved by very large cuts, finally dies over considerable areas. Sometimes the skin is not much changed and the inflammation spreads widely beneath it, the extent of the trouble be-

coming apparent only when incisions are made for its relief. In such cases the severest symptoms of poisoning are present, and the patient frequently succumbs in a few days.

Gaseous Gangrene.

When the bacteria which cause putrefaction are also present, we have the worst inflammatory condition which surgeons ever see. The history of such a case is often as follows: A charge from a shotgun has torn a great ragged hole through the forearm or elbow. Within three or four days the patient is seen by a surgeon, who finds the following conditions: The patient looks very ill; he is weak and stupid. He may have fever, or his temperature may be below the normal; the pulse is rapid and feeble. The wounded arm is enormously swollen. The hand and forearm are black. The shoulder and upper arm are of a dusky-red colour, and the whole limb and the chest upon the wounded side crackle when pressed upon. From the presence of gas beneath the skin, a horrible stench is given off from the part. Amputation is done at once; the tissues bleed but little, and look and smell like meat which has been kept too long. If the limb is cut off at the highest possible point and very early, life may be saved; but usually a fatal result occurs speedily. This disease is called "gaseous gangrene." Since the "antiseptic" treatment of wounds has been generally adopted by surgeons, this condition is rarely seen.

These are a few of the ways in which the bacteria affect wounds. We shall have occasion to mention some others hereafter.

If the writer urged upon his readers the wisdom of seeking surgical aid in cases of recent wounds, he must emphasize the same advice in regard to wounds which are inflamed. An inflamed wound positively requires skilled attention, and when it is remembered that the smallest infected wound may cost the individual his life, the truth of this statement can not be gainsaid. A few practical suggestions may be of value.

When a wound is infected with bacteria a certain time elapses before the symptoms of inflammation appear. This period is rarely less than twenty-four hours, and is often thirty-six or forty-eight hours. The first symptoms are usually pain and redness about the wound, and, if the poisoning is severe, fever, and sometimes a chill.

The Treatment of Inflamed Wounds.

The most important thing in the treatment of inflamed wounds is to allow the discharge to escape in the freest possible manner. If this condition can be maintained, the system is usually able to destroy the bacteria and to get rid of their poisonous products. To accomplish this the wound must be kept wide open, and nothing must be allowed to interfere with the flow of pus.

If the redness spreads and throbbing pain is felt in the part, especially if great tenderness is felt on pressure near the wound, it usually

means that matter is accumulating in the tissues beneath the skin. The matter must then be let out by free cuts with a knife. The condition admits of no delay. When the bacteria have once entered the tissues, the application of antiseptic solutions to the wounded part is only of moderate value. The one indication is to let out the matter at once, and to relieve all tension by incisions. A small puncture with the point of a knife is not sufficient. The inflamed tissues should be very freely divided, so that no pocket remains in which pus can accumulate. A very large cut in the skin is of no consequence compared to the danger of allowing the pus, containing myriads of bacteria and their poisonous products, to be absorbed into the system.

The Use of Antiseptic Solutions.

The wound having been thoroughly opened, various antiseptic solutions are used to destroy the bacteria which remain free in the wound, and to assist the system to get rid of those residing within the tissues. A wound may be thoroughly washed out with corrosive-sublimate solution (1 to 1,000), and the dressing subsequently kept wet with a weaker solution of the same (1 to 3,000) or, better still, the following solution may be used to saturate the dressings: Take of sugar of lead, twenty-five parts; alum, five parts; water, five hundred parts. Mix. This is harmless and effective. It should be used cold. There are many other solutions in use for similar purposes, but this one can be obtained almost anywhere, and there is none better.

How to Apply Antiseptic Solutions.

The solution above given is used in the following way: The gauze or other material is applied thickly in and about the wound, and the dressing is extended even more widely than in the case of the dressings for clean wounds already mentioned. After the dressing is in place, it is saturated with the solution and every hour or two more of the solution is poured on, and the dressing thus kept constantly wet. This procedure seems to aid the tissues considerably in disposing of the bacteria. A badly inflamed wound should be dressed daily, and any new pocket of pus which can be discovered by gentle pressure in the neighbourhood should be opened up freely with the knife. *There is no application which will take the place of a free opening for the escape of wound discharge.*

The Proper Position of the Limb.

The limb should be kept in an elevated position constantly, which will help to diminish the swelling and overcrowding of the blood-vessels.

A WORD IN REGARD TO POULTICES.

When an inflamed part is painful, it means that the products of inflammation are so crowded in the tissues that a considerable amount of pressure or tension exists, the sensitive nerves are compressed, and pain

is the result. This is true whether the inflammation is the result of a wound, a boil, a carbuncle, an abscess, or any acute inflammation caused by pus microbes.

Results of the Crowding of the Products of Inflammation.

Ordinarily, one of two results of the crowding of the products of inflammation occurs. The tissues may succeed in destroying the bacteria before the inflammation has advanced so far that pus or matter is formed. This is accomplished largely by the activity of fixed tissue-cells and white blood cells, which, as before stated, are crowded in and about the inflamed area, and act as a barrier to the further progress of the bacteria. In the inflamed tissue there is another substance formed called fibrin, which acts as a mechanical obstacle to the advance of the bacteria. When the inflammation subsides without the formation of pus, the process is said to have undergone resolution. Where the pus microbes are present in considerable numbers, this is a less common result than the second, which ends in the formation of an accumulation of pus more or less extensive.

The Aggressive Character of Pus Microbes.

Except where pus exists in minute quantities only, it does not remain quiescent. The pus microbes continue to grow and to invade the surrounding structures in the direction of the least resistance. Under favourable circumstances, the inflammatory process is limited in the direction of the deeper structures, and the pus finds its way more or less directly to the surface of the wound, or, in the case of an abscess, a portion of the skin overlying the purulent mass is killed by the interference with its circulation and by the direct action of the microbes on the cells of which the skin is composed, and finally perforation takes place and the imprisoned matter escapes. It has been truly said, "Nature is a good physician but a poor surgeon"; frequently the efforts of the tissues are only partly successful, and the surgeon's art is needed to expedite or make possible the cure.

Poultices favour the Development of Bacteria.

As has been stated already, the materials from which poultices are commonly made contain bacteria. Even the center of a baked loaf of bread may contain living microbes in considerable numbers. Although possibly free from bacteria when applied, the warm moist bread-crumb, the linseed or flaxseed meal, form an ideal soil for the rapid multiplication of such microbes as are sure to gain access to it from the wound or from the surrounding skin.

It is impossible to mix the materials from which poultices are made with antiseptics in such a manner as to render them unfit for the growth of microbes. These facts alone are sufficient to show that a poultice is an unsuitable dressing for a wound.

The action of a poultice is to paralyze the efforts which the tissues

make to limit the bacteria to a small area. Under the enervating effect of the heat and moisture, the barrier of cells and fibrin which holds the microbes in check is broken down and melted, the blood-vessels lose their tone, and the white cells escape from their interior in greatly increased numbers, but these cells are enfeebled and are rapidly converted into pus by the action of the microbes. The tissues become wet and soggy, and new areas are laid open for the entrance of the bacteria and their poisonous products. It is true that oftentimes the tension is relieved, and that, for a while at least, pain is diminished or abolished; but this result is accomplished at the cost of a wider area of infection. In other words, *the action of a poultice is to spread the poison and to render the tissues less liable to resist the advance of the bacteria.*

The Pernicious Results of Poulticing.

During the past few years the writer has seen several thousand cases of wounds and acute suppurative inflammations of various kinds which had been treated with poultices, and he can speak feelingly and perhaps with that authority which a moderate experience can give, and he has no hesitation in saying that he has never seen a case among those which have come under his notice whose condition had not been made worse by poulticing, and that hundreds of permanently crippled hands and arms and not a few lost lives were due directly to this most pernicious form of treatment. He would, therefore, urge his readers never to apply a poultice to a wound of any sort, or to any form of acute inflammation where pus is already present or is likely to be produced. A cut with a knife is the surest, quickest, and best way to get rid of retained matter, wherever it is situated, and the cut can not be made too early.

Possibilities of Infection from Pus Microbes.

From the time a wound is made until the last skin cell takes its place on the healing surface and thus completes the protective covering of the deeper parts, infection with pus microbes may take place, but a wound when fresh is much more susceptible to their influence than it is at a later period, when the healing process is already under way. While this is true of the pus microbes, it does not obtain in the cases of certain other bacteria, notably of the germs of erysipelas. This fact makes the protection of wounds by an antiseptic dressing imperative until healing is complete.

COLD.

The continued reduction of the temperature of an inflamed part during the early stages before pus has formed is sometimes useful to diminish the pain and to cause contraction of the blood-vessels and consequent diminution of congestion. It also may have the effect of stopping the growth of the bacteria, because a temperature lower than that of the body is commonly unfavourable to their development. Cold should not

be used after pus has formed; it then has a bad effect upon the vitality of the tissues.

Cold may be conveniently applied by means of a rubber bag or a pig's bladder filled with cracked ice. Its application should be continuous.

Cold is not generally used in the treatment of inflamed wounds, but in inflammations beneath the skin where suppuration is threatened.

POISONED WOUNDS AND THEIR TREATMENT.

The Nature and Effects of Poisoned Wounds.

When a poisonous animal virus, or any animal or vegetable poison other than the bacteria, is introduced into the tissues through a wound, we speak of the condition as a "poisoned wound." The wound may be a mere scratch or the poison may be carried deeply into the tissues. Examples of such wounds are the bites of venomous serpents and lizards, the stings and bites of insects, and the wounds made by arrows or other weapons, the points of which have been smeared with poison. In snake bites the venom is forcibly injected into the wound through the hollow or grooved fangs which convey it from the poison glands. The effects, local and general, of such wounds vary greatly according to the character of the poison and the amount which is introduced into the wound. The health and strength of the individual are also not without influence.

Snake Bites.

The poisonous snakes of North America are the rattlesnake, the American moccason, and the copperhead. The poison of all venomous snakes is similar in its effects, the severity of the symptoms depending upon the factors mentioned above and upon the rapidity of absorption.

When the venom is injected directly into a vein, the system is permeated by the poison in a few seconds or in a minute or two at most, and symptoms of sudden mental and physical collapse come on at once. When the wound is a mere abrasion, or when the skin and the tissues just beneath it, in regions where blood-vessels are not very numerous, alone are infected, the absorption of the poison may be delayed and severe symptoms may be absent. Very commonly terror is extreme, and may cause a condition of profound shock after the bite of a harmless reptile.

Symptoms.

The usual symptoms of snake bite are severe pain in the wound, local swelling and discolouration of the skin, muscular weakness, a rapid, feeble pulse, coldness of the extremities, clammy sweat, headache, embarrassed breathing, nausea and vomiting, and, if the result is to be a fatal one, convulsions, unconsciousness, and death. If the individual survives the immediate effects of the poison, the swelling spreads widely and is often followed by death of the swollen

tissues to a greater or less extent. Death may occur in an hour or may be delayed for several days.

There is no effective antidote for snake bite. The limb should be constricted at once above the wound by means of an improvised tourniquet, which must be twisted as tightly as possible. The wound itself may be cut out with a knife which goes around it three fourths of an inch from its margin, or the wound may be sucked by the individual himself or by another who has no abrasion of the lips or inside of the mouth. This treatment may be followed by a cut which greatly enlarges the wound and allows the venom to be washed out by the flow of blood, and at the same time makes the poison more accessible to the action of a red-hot iron, a live coal, or to a strong solution of permanganate of potassium, or to any strong mineral acid. These agents destroy the tissues which contain the poison and the poison itself.

Treatment.

To stimulate the enfeebled heart any strong liquor may be given in large doses. Care should be taken not to kill the patient with alcohol. Remember that children are easily poisoned with liquor.

A solution of permanganate of potassium, one grain to the ounce of water, may also be injected through a hollow needle into the parts around the wound with the idea of destroying such poison as may still be present. Ammonia water has been thought to act in a similar manner, but it is of doubtful efficacy.

Persons have sometimes saved their own lives by the immediate amputation of the wounded finger or toe.

Investigations made recently in the Pasteur Institute at Paris by Dr. Calmette point to a probable solution of the problem of preventive inoculations in snake bites.

Dr. Calmette found that the blood serum of an animal dead of the bite of the cobra (the serpent which destroys so many human lives in India), when injected in small quantities into the tissues of other animals, produced in the animal inoculated complete immunity from the cobra venom. The inoculations were made with increasing quantities of serum and four days were required to complete the protection.

Dr. Calmette also found that a solution of chloride of lime in water, freshly prepared, would, when injected into the tissues of an animal recently bitten by a cobra, prevent the deadly effect of the poison. These injections had to be made within an hour from the time the bite was received, and a considerable quantity of the solution had to be used. The action of the chloride of lime is to prevent the coagulation of the blood which the venom produces and the consequent interference with the circulation of blood in the lungs.

These experiments have, as yet, been confined to the lower animals,

and it is therefore too soon to assert positively that they will be as successful in man.

The tarantula, a large, poisonous spider inhabiting the warmer parts of America, produces by its bite symptoms similar in kind but milder in degree than those just described. The treatment of tarantula bite is the same as that of snake bite, but need not be so heroic, since death rarely occurs.

The Stings of Bees, etc.

The stings of bees, wasps, and hornets produce painful but not dangerous symptoms. Treatment.—Remove the sting if it be left behind, and apply an alkaline solution to the part—ammonia water or a solution of washing soda. Wet clay is a popular and effective remedy.

Ammonia water relieves the irritation of the skin produced by the bites of fleas, bedbugs, and mosquitoes.

Poisoned-arrow Wounds.

The active ingredient of the substances used by the savage natives of Africa to poison the points of their arrows is usually the juice of some plant. Frequently other ingredients are added, such as powdered red ants, the heads of poisonous serpents, or the body juices of the larvæ of certain beetles which feed upon poisonous plants and thus become themselves poisonous. Putrid animal matter is sometimes mixed with the other materials.

An examination of the poisoned arrow-heads brought from various parts of Africa has shown that many of them contain a poisonous substance similar to or identical with the drug called *Strophanthus*, which is obtained from the juice of an African tree and is largely used in civilized medicine as a heart stimulant. Its action is first to stimulate and then, in larger doses, to paralyze the heart.

Some of the men accompanying Stanley in his journey up the Congo River died in a few minutes after being wounded with arrows so small that the puncture was not much larger than the prick of a darning-needle. Those who survived the immediate effects suffered from inflammation and gangrene of the wound, and a considerable number of those wounded died, after some days, of tetanus. The most effective remedy seemed to be the injection into the tissues about the wound of a solution of carbonate of ammonia.

The natives of some of the countries of South America use a poison on their arrows and darts called "curare." This is a violent poison, and causes paralysis of all the voluntary muscles of the body.

Treatment.

The treatment of poisoned-arrow wounds would be the extraction of the arrow-head as soon as possible, constriction of the limb to prevent absorption, and incision and disinfection of the wound by one of the methods already given. The removal of the head of the arrow is rendered difficult by so contriving it that pull-

ing on the shaft of the arrow usually breaks off the head and leaves it embedded in the tissues.

GENERAL TREATMENT OF THE WOUNDED.

Under the treatment of shock and excessive bleeding the writer has already indicated what should be done for persons suffering from these conditions.

Quiet.

Generally the quieter the wounded part is kept after it is once dressed, the better, and the same principle applies to the individual himself.

If a wound does not become infected, little or no general treatment is required. After the most severe surgical operations there is commonly very little pain, and only a temporary constitutional depression, providing no infection with pus microbes takes place.

Nourishment.

When infection occurs, the system is depressed by the continual absorption of poisonous products, and plenty of any kind of food that the patient can take, especially milk, eggs, and strong soups, must be given to support the strength. If there is no appetite, it is better to give food at regular and short intervals in small doses.

Stimulants.

Whiskey, strychnine, and various other tonic drugs are used to support the circulation and vital powers. Morphine is used to relieve pain and to enable the patient to sleep. (See *Medicines and Treatment.*)

The so-called antipyretics—quinine, antipyrine, etc.—are not commonly used to diminish the height of the fever following infected wounds, because these drugs have only a temporary effect, and depress the heart and the general vitality of the patient.

Sponging.

Sponging the body with alcohol and water, or with tepid water alone, is of use to lower the temperature. These applications are usually refreshing, and help to keep the skin in a healthy condition. They may be repeated several times daily, if agreeable.

Care of the Bowels.

The bowels should be kept open, and much water may be taken with advantage by the mouth, to encourage the action of the kidneys, through which many bacteria are eliminated from the system.

Care of the Mouth.

As in any disease accompanied by continued fever, special attention should be paid to the mouth. An antiseptic mouth wash of some sort should be used frequently. There is nothing better or more refreshing for this purpose than a solution of peroxide of hydrogen used one half strength. Listerine, diluted with an equal quantity of water, answers the purpose well.

CONTUSIONS.

Blows with blunt instruments, falls from a height, crushing injuries from various causes, often result in more or less extensive bruising or laceration of the deeper tissues without any break in the skin. We call such injuries *subcutaneous wounds or contusions.*

The gravity of such conditions varies with the amount of injury done to the deeper parts and with the importance of the injured organs.

A constant accompaniment of contusions is the laceration of a certain number of blood-vessels, usually capillaries and small veins, which causes an effusion of blood beneath the skin. This effusion of the blood beneath the skin gives rise to the swelling which follows a bruise and to the familiar discolouration of the skin which is known as a black-and-blue mark. The arteries, on account of their tough and elastic walls, usually escape rupture. Occasionally a large artery is ruptured. Then a pulsating swelling full of blood is formed which may give rise to serious symptoms, and, if the vessel is not cut down upon and tied, a fatal result may take place from ulceration and rupture of the swelling, and consequent loss of blood.

Effusion of Blood beneath the Skin.

False or Traumatic Aneurism.

Contusions which cause the rupture of important organs like the lungs, the liver, the intestine, the bladder, or where very extensive laceration of the soft parts and crushing of the bones of a limb are produced, are very commonly attended by grave symptoms of shock, and may result fatally from this cause alone.

Shock.

When inward bleeding in large amounts takes place into one of the body cavities—the chest, the abdomen—symptoms may be produced due to the withdrawal of the blood from the circulation—*i. e.*, symptoms of hæmorrhage—or the effused blood may, by pressure upon the viscera contained within the cavity, cause symptoms of various kinds. In the chest, effused blood may produce embarrassed breathing or interference with the action of the heart. In the abdomen, the symptoms produced by the pressure of effused blood are usually not marked, shock is often present, and a varied train of symptoms due to the injuries of special organs. Within the skull, with its unyielding walls and very delicate contents, the presence of a clot of blood may give rise to serious or fatal symptoms which will be spoken of under *Injuries of the Skull.*

Internal Hæmorrhage.

Injuries of Nerves and Muscles.

The injuries of nerves and muscles give rise to the same loss of function which occurs in open wounds, but complete recovery is the rule unless considerable intervals are left between the divided structures after healing is complete.

The pain caused by contusions varies greatly, according to the nerve-

supply of the injured parts. When nerve-trunks are injured, the pain is often intense and radiates along the course of contused nerves. In sensitive regions, where the tissues are of a firm consistence, effused blood may cause a good deal of pain from tension and pressure.

Pain.

The subsequent history of an ordinary contusion of the soft parts depends upon whether the bruised tissues, including the skin, live or die. In the former case, the effused blood usually undergoes absorption. Coagulation first takes place, the fluid part of the mass is then absorbed by the lymphatics, and afterward the clot liquefies and is taken up by the system in the same manner. The colouring matter of the blood, which at first causes a blue or dark bluish red discolouration of the skin, passes through various changes of colour—brown, dark green, green, and lastly yellow—and gradually is absorbed, the yellow colour persisting sometimes for months. Where the effused blood was evenly diffused through the tissues no trace of the injury remains, but when a considerable cavity filled with blood exists, a certain amount of scar-tissue fills the space, or, occasionally, a cavity filled with a watery brownish fluid remains, surrounded by scar-tissue. Such cavities are sometimes found in the brain as the result of old injuries. When the crushing force has been sufficient to destroy the deeper tissues, the dead parts are removed by absorption, and the living parts are reunited by new tissue of like kind, or by scar-tissue, if the space to be bridged over is too great. In case the skin is killed, an open wound results, in which healing is apt to be delayed by inflammation of greater or less severity.

Subsequent History.

The most important difference between open wounds and contusions arises from the fact that the unbroken skin offers a barrier to the entrance of the bacteria. Hence subcutaneous injuries, when uncomplicated, usually heal without suppuration. A small break in the skin, however, may be sufficient to form a port of entry for bacteria. When infection occurs, the blood beneath the skin and the bruised tissues are in an unfavourable position to resist the attacks of the microbes, and a more or less extensive abscess results. Rarely suppuration occurs in a contusion where no break in the skin exists. This fact and others of like character have led to a good deal of investigation. The conclusion arrived at is that, in a healthy individual, a certain number of pus microbes may be present in the tissues and in the blood from time to time without causing inflammation, the sound body being able to dispose of them ; but given an injury or some other local condition which reduces the vitality of the part, the microbes may settle there and produce their characteristic effects.

Difference between Open Wounds and Contusions.

Subcutaneous bleeding, even from an artery of some size, often stops of itself from the pressure of the effused blood. Pressure by a moderately firm bandage may be used, however, to aid Nature, also elevation of the limb, and the application of cold in the form of an ice-bag, or an evaporating lotion, such as water and alcohol, equal parts; extract of witch hazel, diluted with water; or the solution of sugar of lead, alum and water may be used. These applications may be continued for a few hours or longer if the swelling seems to grow larger and the discolouration of the skin spreads rapidly.

Treatment of Contusions.

Cold should not be used in severe contusions where the skin is cold and insensitive, for fear of further diminishing its vitality. In such cases, the limb should be cleaned thoroughly and disinfected, as though there were an open wound, a light dry antiseptic dressing should be applied, the limb enveloped thickly in ordinary cotton-batting, and over this a bandage, to hold it in place, put on rather loosely. The limb should be elevated and supported on pillows, or a board covered with some soft material. Prominent bony points should be protected by thick pads of cotton, to prevent the injurious effect of pressure.

Slight wounds of the skin over a contusion should always be treated antiseptically.

In contusions of moderate severity, the main object of the treatment is to cause the early absorption of the effused blood. This is accomplished by massage, *always rubbing toward the trunk*, beginning with gentle rubbing and increasing the pressure after a few minutes, when the tissues become less sensitive. The rubbing may be continued for ten minutes, and should be done once or twice a day. A valuable aid to massage is an ointment composed of one part of ichthyol and ten parts of lard. This should be rubbed in during massage.

Massage.

Douching with hot and then with cold water also aids in the absorption of the blood, and well may be used in conjunction with the measures just described. By these means considerable effusion may be made to disappear in a few days.

Douching.

When infection with pus microbes takes place and pus forms, the treatment is that of abscess and inflamed wounds. The treatment of contusions of special regions will be mentioned under the *Injuries of Special Regions.*

CHAPTER II.

SURGICAL DISEASES OF THE SOFT PARTS.

ACUTE ABSCESS.

An acute abscess is a collection of pus in the tissues, due to infection with pus microbes through a wound in the skin or mucous membrane, or to an infection proceeding from a similar inflammation somewhere else in the body.

A favourite site for abscess is in the loose tissue beneath the skin.

Symptoms.

The symptoms of abscess are pain, fever, and, if the inflammation is near the surface, heat and redness of the skin and a peculiar elastic feeling known as *fluctuation*, due to the presence of the confined pus. Another important sign of the presence of pus is extreme localized tenderness on pressure, especially in sensitive regions. The pain of abscess varies greatly. In sensitive regions a drop or two of pus may cause intense suffering, while in loose tissues scantily supplied with nerves, a very large accumulation of pus may give rise to but little pain. The fever depends upon the absorption of poisonous products, and varies greatly in degree with the size and situation of the abscess. The fever and pain usually subside immediately after the pus is evacuated. The redness and heat of the skin indicate that the pus is near the surface. The redness is usually most intense over the centre of the abscess and shades off gradually into the surrounding healthy skin. All the symptoms of acute abscess are commonly developed in a few days.

Treatment.

The treatment of abscess is to let out the pus through a cut as soon as its presence may be detected. The cut should be made over the point of greatest tenderness and extended in a direction such that gravity will assist the subsequent drainage of the cavity. If the abscess is large, more than one opening may be needed. Drainage should be maintained by the introduction into the abscess cavity *by the most direct route* of a piece of clean, soft, rubber tube. When the abscess is not deep the incision itself may be sufficient to secure a proper drainage, or a small piece of antiseptic gauze may be packed loosely into the opening, which will suffice to prevent the closure of the wound and a reaccumulation of the pus. The opening of an abscess should be done with all the antiseptic precautions described in the treatment of wounds and an antiseptic dressing should be applied. Washing out the cavity of an acute abscess may generally be omitted, as it is very painful and does not materially aid in the cure. *A free exit for the pus is the essential part of the treatment.*

In acute abscesses of moderate size, which have been properly opened, the drainage-tube usually may be removed permanently after three or four days. When the cavity has ceased to discharge pus the presence of a drainage-tube delays the healing.

Sometimes healing proceeds rapidly up to a certain point, but a narrow tubular tract is left in the tissues which refuses to close and discharges continually a little pus. We then resort to various stimulating applications to hasten the closure of the *sinus*, as it is called. We inject into the tract through a small glass syringe Peruvian balsam or tincture of iodine. Frequently such applications repeated every day or two will lead to a speedy cure. If not, we suspect the presence of dead or inflamed bone or some other dead tissue, for the removal of which a surgical operation may be necessary.

It is a good rule to open abscesses early. The patient will thus be spared suffering and danger from the absorption of poisonous products, and the size of the scar will be reduced to a minimum.

The general health should be supported by tonics, and the general rules given for the care of patients suffering from inflamed wounds apply also here. Absolute rest for the part is important.

During the early stages of the disease *cold* may be used with the idea of preventing the formation of pus. An ice-bag or a cold, wet antiseptic dressing—as previously described for inflamed wounds—may be used, and the limb elevated. These measures sometimes succeed. They should not be used after high fever, fluctuation and extreme tenderness give evidence of the presence of pus.

BOILS.

A boil is an acute localized inflammation of the skin caused by infection with pus microbes. The infection usually takes place around the root of a hair, in a sweat-gland, or in one of the sebaceous glands of the skin. As a general rule, the process ends in the formation of a small abscess and the death of a small portion of the skin. Boils are accompanied by pain and discomfort and often by slight fever. They may appear upon any portion of the skin, the most common sites being the back of the neck, the back, the buttocks, the armpit, and the face. They are apt to occur when the general health is impaired from any cause, especially during convalescence from fevers, and are not uncommon among those who change their underclothing infrequently and bathe rarely.

Symptoms.

A boil usually begins as a small, red, tender, elevated spot in the skin resembling an ordinary pimple. The redness and swelling increase, and after a few days a small abscess is formed. The inflamed area varies in diameter from a quarter of an inch to an inch

and a half, and seldom extends into the deeper parts, although it may rarely be the starting-point of a progressive and serious inflammation, especially about the face.

If the boil is not opened in a few days, a small portion of the skin dies and comes away, allowing the pus to escape. This discharge of pus is usually followed by the discharge through the opening of a bit of dead tissue, vulgarly known as the core of the boil. The inflammation then subsides rapidly, and the little cavity heals from the bottom.

Local Treatment.

The treatment of boils is local and general. The effort to abort boils is usually unsuccessful. Wet dressings of sugar of lead and alum solution may be tried, or of a solution of three parts of ichthyol in one hundred parts of water. A cloth wet with either solution may be kept on the part. The best treatment is to open the boil early by a small cut, and thus let out the pus and relieve the tension. Immediate relief from pain is obtained, and usually a rapid cure is the result. A wet dressing of either of the above solutions may then be applied. The general treatment consists in the administration of iron and strychnine or some other tonic, and in attention to the skin. A daily hot bath should be taken with plenty of strong soap. The "green soap" of the pharmacists is good. The baths remove from the surface of the skin and from the skin glands or pores the bacteria which cause the trouble. Russian or Turkish baths taken two or three times a week answer the same purpose. The internal use of the sulphide of calcium so often prescribed to prevent the recurrence of boils is of doubtful efficacy.

General Treatment.

CARBUNCLE.

A carbuncle may be described as a number of boils situated close together. The area of inflamed tissue varies in size from an inch to six or more inches in diameter. The skin and the tissues beneath it are inflamed, and sometimes the muscles are invaded. The inflamed tissues die and undergo purulent softening. It is more common in old people and in the debilitated, and is a frequent complication of diabetes. In the robust, the result is usually favourable; in the feeble and diabetic, the disease often ends in septicæmia or pyæmia and death.

Symptoms.

Carbuncle occurs most often on the back of the neck, on the back, and on the face. In the last situation it may produce death by extension of the inflammation to the brain and its membranes. It begins as a hard, painful, tender swelling beneath the skin. There are fever, prostration, and other symptoms of septic poisoning. The skin becomes red and inflamed over the swelling, and is finally perforated, usually in several places. Pus exudes through the openings. If not operated upon early, a good deal of skin may die

and leave a surface of dead tissue beneath of variable depth, which is slowly separated from the living parts. The cavity heals in a tedious manner from the bottom. By the death of portions of skin and the deeper tissues here and there a honeycombed condition may be produced.

Treatment.

In the early stages, the application of an ice-bag may serve to limit the inflammation to some extent. The only treatment which serves to shorten the disease and to preserve life is the operative removal of the dead and inflamed tissues, saving as much as possible of the skin, followed by thorough disinfection of the cavity and the application of an antiseptic dressing. The general treatment does not differ from that of inflamed wounds. It is needless to say that the services of a surgeon are required.

GANGRENE AND NECROSIS.

The term gangrene, in its most modern significance, is used to designate the changes produced in tissues already dead by the growth in them of the bacteria of putrefaction.

Causes of Necrosis.

Necrosis means death of the tissues from any cause. Among such causes may be mentioned: Mechanical violence, cold, heat, caustics, complete stoppage of the arterial blood supply (which may be sudden, from injury or from plugging of the vessel by material carried from the lining of a diseased heart; or gradual, from disease of the vessel itself), complete stoppage of the large veins of a limb from disease or injury, continuous pressure (an example of which is a bedsore), diseases of the nervous system, the continued use for food of bread made from diseased rye, and, finally, the growth in the tissues of various forms of bacteria other than the putrefactive bacteria.

A detailed description of these conditions must be sought for in works on general surgery. To a non-medical person, the only practical bearing of this topic relates to such knowledge as would enable him to recognise the commoner conditions of necrosis on the surface of the body.

True or Moist Gangrene.

We have spoken of *Progressive Gaseous Gangrene.* It is a disease the nature and seriousness of which are not likely to be overlooked by any one. We have also mentioned certain inflammatory conditions caused by pus microbes and attended by necrosis or death of the tissues, and we shall here confine ourselves to the consideration of the symptoms of necrosis as it occurs in the extremities under the common name of gangrene.

We distinguish two types of this condition, according as infection with putrefactive bacteria is present or absent. First, *True* or *Moist Gangrene*, where the dead tissues putrefy as the result of

the growth of the putrefactive bacteria, the pus microbes attack the living parts adjacent, and a more or less intense poisoning of the system occurs from the absorption of bacterial products. Second, *Dry Gangrene* or *Mummification*, in which the dead part dries, shrinks, becomes hard, and does not undergo putrefaction. Infection with pus microbes is absent, or, if it occurs at the line of separation of the living from the dead parts, it is usually slight. Hence systemic poisoning is absent or not severe. This form of necrosis is most common in the aged. It usually begins in one of the toes, often in the great toe, and is due to failure of nutrition from gradual obliteration of the arteries.

Dry Gangrene or Mummification.

When the main artery of a limb is destroyed by an injury, or plugged by a clot, no pulsation can be felt in the vessels of the limb below the point of injury or the situation of the clot, as the case may be. If the smaller vessels are unable to carry on the circulation, the pulsation does not return, and gangrene may be expected.

Symptoms.

Pain.—If a large artery is suddenly plugged, severe pain is commonly felt in the entire limb. Where the stoppage is gradual, moderate pain may be felt for weeks or months. Acute inflammation ending in gangrene is attended by severe pain, which ceases or grows less when death of the tissues is complete.

Tenderness.—As long as the prick of a needle can be felt, the suspected part is not dead.

Temperature.—When acute inflammation ends in gangrene, the part does not become cold until death is complete. Gangrene caused by gradual interference with the nutrition of a limb is preceded by coldness of the skin. This is usually true of gangrene caused by sudden plugging or destruction of the main artery.

Swelling.—In moist gangrene, the tissues swell from imbibition of fluids from the blood-vessels and surrounding structures. If gas is produced, the swelling increases. In *Aseptic* or *Dry Gangrene* the part shrinks and becomes hard.

Gas in the tissues is produced by certain of the putrefactive bacteria. It consists of sulphuretted hydrogen (having the well-known odour of bad eggs) and of certain of the decomposition products of fat. Its presence is easily detected by pressing the limb with the tips of the fingers, when a crackling sound and sensation are noticed.

Colour.—When caused by stoppage of an artery, death of the tissues is preceded by an unnatural paleness of the skin, followed by a leaden grey discoloration, which gradually changes into a greenish black. In moist gangrene, blisters containing blood-stained fluid form on the surface.

Condition of the Tissues.—In moist gangrene, the dead tissues become soft, and an offensive fluid exudes from the surface. In dry aseptic gangrene, the dead tissues shrink and become hard, as before stated, and emit no bad odour. The extent of the process depends upon the previous vitality of the tissues, upon the size and number of the vessels obstructed, upon the amount of infection, and upon the virulence of the bacteria.

In the moist variety, where pus microbes are present, the living tissues are separated from the dead by suppuration when gangrene is arrested. In aseptic gangrene, absorption of the dead tissue takes place if the mass is not too large, otherwise it is diminished in size by the activity of the living cells, and separation takes place by the formation between the living and the dead parts of a wall of such tissue as was described as forming in the healing of clean wounds.

General Symptoms.

In aseptic gangrene, there are no symptoms of general poisoning. In the moist, putrefactive variety, the general symptoms are those of a more or less intense septicæmia, which will be spoken of elsewhere.

Treatment.

It is obvious that no line of treatment can be proposed which would be practicable for a non-medical person to carry out. The rule among surgeons is that, where no symptoms of general poisoning exist, the dead tissues are not to be removed until a distinct line of separation occurs. Where dangerous symptoms of poisoning are present and the death and infection of the tissues are spreading, amputation, done early and at a point far removed from the disease, offers the best chance for recovery. When gangrene is threatened from impeded circulation the limb should be cleaned, covered with a dry antiseptic dressing, wrapped loosely in cotton-batting, and slightly elevated. For the prevention of gangrene from pressure the reader is referred to the article on *Nursing the Sick*, under the head of *Bedsores.*

In the aged and in those suffering from diabetes, trivial wounds should receive the most careful antiseptic treatment. The general treatment consists in the administration of the most nourishing food, tonics, and alcohol in the form of wine or liquor. It is similar to the general treatment of inflamed wounds.

ERYSIPELAS.

Erysipelas is an acute, contagious inflammation of the skin and mucous membranes, caused by a special microbe.

Means of Infection.

Infection takes place through a wound or abrasion, large or small. A period of from fifteen to sixty hours elapses from the time of inoculation to the development of the disease. The disease is carried readily from one person to another by fingers,

sponges, instruments, etc., and, before the mode of infection was understood, epidemics of the disease were very frequent. After childbirth women are very susceptible to infection with erysipelas through the genital tract. In these cases a rapidly fatal form of septicæmia is produced. Pure erysipelas is not attended by the formation of pus.

Symptoms.

The disease is often ushered in by a chill, or, in children, by a convulsion, followed by fever which sometimes rises in a few hours to 103° to 104° Fahr. The pulse is at first full, and the rapidity about 100. Later in the disease the pulse may become more rapid and feeble. Nausea and vomiting are common. Loss of appetite, headache, and prostration are usually marked. Delirium is frequent, especially in erysipelas about the head. In a few hours or in a day the inflammation of the skin appears. If near a wound, the discharge of pus from the wound is rather diminished than increased. The inflamed skin is bright rosy red, firm to the touch, and slightly elevated. The swelling is most marked about the face and eyelids, and in other regions where the tissues are of loose texture. The inflammation spreads rapidly in irregular, wavy lines, always with a sharply marked border. Often the inflammation disappears in the spot first affected, while advancing elsewhere. Blisters are frequently formed on the surface. They may coalesce into large blebs filled with watery fluid. If infection with pus microbes takes place this watery fluid may become purulent, or, in severe types of the disease, bloody. A burning or itching is complained of in the inflamed skin. Severe pain is not present.

Prognosis.

The duration of the disease is variable, from two or three days to several weeks, depending upon whether the process remains confined to a narrow area or spreads from one place to another over a large extent of surface. In the robust, erysipelas is rarely fatal. In the debilitated, and especially in those who habitually drink to excess, it is a very dangerous disease. One attack predisposes to others.

Erysipelas of the face and scalp is usually attended by high fever, prostration, and often by delirium. A fatal result may occur without special complications, or extension to the brain or its membranes may produce death.

Erysipelas of the mucous membranes is most common in the throat. It may occur alone or as a complication. It is dangerous, owing to the swelling which may close the opening into the windpipe, and thus produce asphyxiation and death.

Secondary infection from pus microbes may produce abscesses beneath the skin or a condition previously described under the name of *Progressive Septic Phlegmon*, with much destruction of tissue and often fatal poisoning.

Erysipelas is ordinarily followed by a scaling off of the skin over the previously inflamed area.

People with severe attacks of erysipelas are commonly very ill indeed. The general treatment consists in giving plenty of easily digested food, with stimulants, tonics, and opium, when needed to produce sleep.

Treatment.

Erysipelas is so variable in its duration that it is not easy to say what application succeeds best. Probably no local application has any very marked effect in arresting the inflammation. The number of remedies which have been used and lauded is very great. Among those which seem to have some effect in limiting the spread of the disease, and to do much to allay the discomfort of the patient, may be mentioned the following: A solution of ichthyol, 3 to 5 parts in 100 parts of water. An ointment of ichthyol, 10 parts in 90 parts of lard. A solution of carbolic acid, 1 part; water, 100 parts. An ointment of carbolic acid, 1 part; lard, 50 parts. A solution of corrosive sublimate, 1 part; water, 5,000 to 10,000 parts. A solution of the sulpho-carbolate of sodium, 1 part; water, 100 parts. The solution of sugar of lead and alum before mentioned. A solution containing sugar of lead, two teaspoonfuls; laudanum, one tablespoonful; water, one pint.

Cloths wet with these solutions are laid upon the inflamed part, and more of the solution is poured on from time to time. On the face a mask of sheet lint or several layers of gauze may be applied, with holes cut for the eyes, nose, and mouth.

Carbolic acid applied to a large surface of skin may cause systemic poisoning, even in weak solutions. The symptoms are an olive-green or smoky discoloration of the urine, which, in some cases, may become almost black. The general symptoms are headache, giddiness, loss of appetite, and vomiting. In severe cases, other symptoms are added—cramps of the muscles, collapse, unconsciousness, and death. The local application of carbolic acid should, of course, be stopped at once when symptoms of intoxication appear.

Corrosive-sublimate solutions sometimes produce an intense and very persistent inflammation of the skin when the applications are long continued.

The ointments are spread on lint or smeared over the surface of the skin.

A series of hot soap-and-water baths should be taken after an attack of erysipelas to get rid of the contagion as far as possible. The hair should receive especial attention. The clothes, bedding, and woodwork of a room should be washed with soap and water, and afterward with 1-to-1,000 corrosive sublimate. The walls should be rubbed down with bread crumb.

SEPTICÆMIA OR SEPTIC INFECTION.

Cause.

Under this name are included a very varied series of symptoms produced by the growth of pus microbes in the tissues. The writer has already indicated the more important symptoms of some of the forms of septicæmia in the preceding chapter, under the head of *Inflamed Wounds and their Treatment.* The products of bacterial growth are absorbed from a localized inflammation and poison the system. In severe cases (*Progressive Septicæmia*), the bacteria enter the blood-current and multiply therein, furnishing another source of poison, and interfering with the functions of vital organs. The bacteria may gain access to the tissues through a wound of the skin or mucous membranes, large or small, or through an ulcerated surface of any kind.

Symptoms.

The general symptoms vary much in intensity, according to the extent and character of the local inflammation from which the disease originated, the amount of poison absorbed, and the number of bac teria present in the blood. The most constant general symptoms are *fever and prostration.* The initial symptoms begin from twenty-four to seventy-two hours after infection has taken place. In some cases the first symptom is a chill, regularly followed by fever and prostration. The pulse is rapid and, in severe cases, very feeble early in the disease. Patients with septicæmia are stupid and apathetic, as a rule, and do not appreciate the danger they are in.

History.

The course of the disease may be very short, a fatal result occurring in forty-eight hours or less, as in some cases of general peritonitis, following perforation of the intestine from injury or disease, in which the contents of the bowel escape into the cavity of the belly, and cause a violent and rapidly fatal form of inflammation.

In some cases life may be prolonged for weeks or months, the patient dying finally from exhaustion or pyæmia. Recovery depends upon the possibility of disinfecting the original seat of the inflammation, so that the source of the poison may be cut off, upon the power of the tissues to destroy the bacteria which have gained access to the blood, and upon the strength of the individual.

PYÆMIA.

Cause.

Pyæmia is caused usually by purulent inflammation in the interior of a vein. The infection of the vein takes place from a neighbouring inflamed wound or other local source of bacteria. A clot containing bacteria is formed in the inflamed vein, the clot softens, and portions of it are carried by the blood-current to distant organs, where the bacteria produce new inflamed areas and abscesses.

Symptoms. The characteristic features of pyæmia are *fever*, which varies much and suddenly in intensity, going up and down from hour to hour and from day to day; irregular chills, each chill being succeeded by a rise of temperature, which in turn is followed usually by a sudden fall and sweating; and *marked prostration.*

The local symptoms depend upon the original inflammation and upon the secondary abscesses, which may occur in the lungs, the kidneys, the joints, the muscles, beneath the skin, or, in fact, in any situation.

History. The disease may run an acute or chronic course. In the acute cases there are usually many small abscesses, and death occurs at the end of two or three weeks. The patient emaciates rapidly, there is great thirst and profound weakness, the skin is dry and of a yellowish colour, there is complete loss of appetite. As the fatal termination approaches, delirium and stupor are usually present, and possibly diarrhœa. Death takes place usually from gradual failure of the heart, or, at times, suddenly, from plugging of the artery which carries the blood from the heart to the lungs. In chronic cases life may be prolonged for many months. The patient finally recovers or dies of exhaustion.

Both pyæmia and septicæmia have become much less frequent since the antiseptic treatment of wounds has been generally adopted.

TETANUS.

Tetanus, or lock-jaw, as it is popularly called, is a disease produced by a rod-shaped bacterium, the *Bacillus tetani*, which regularly inhabits the soil and grows only in the absence of atmospheric air. The disease is most frequent in warm climates.

Means of Infection. Infection takes place through a wound. The tetanus microbe does not cause suppuration, and may not interfere with the healing of a wound, but produces poisons which, being absorbed, cause intense irritation of the nervous system, and continuous, spasmodic contraction of the muscles, particularly of the muscles about the head, neck, and back. Accidental wounds about the hands and feet are especially likely to be contaminated with soil and dust, and hence such wounds are most apt to be followed by tetanus. Deep punctured wounds furnish the best protection to the bacteria from the air, and in them the bacteria of tetanus find a suitable soil.

History. The time elapsing from infection to the development of the disease varies from twenty-four hours to several weeks. Cases that develop early run an acute and fatal course. Death may take place in from twenty-four hours to a week. Chronic cases develop slowly and late, and are much less fatal. About seventy-five per cent of all cases of tetanus end in death.

In acute cases the disease often begins with pain in the back of the neck, followed by inability to open the mouth from spasm of the muscles that move the jaw. There is sometimes a chill, and always fever and a rapid, feeble pulse. The spasms extend from one group of muscles to another, involving successively the muscles of the jaws, the neck, the back, and finally the muscles of respiration that move the ribs and the diaphragm.

Symptoms.

When the muscles of the back are in a state of spasm, the body is arched backward, so that, when lying face upward, the patient rests upon the back of the head and the heels, a condition known as—

Opisthotonos.—The affected muscles remain hard and contracted, but further spasmodic contractions occur from time to time. The spasms are attended by excruciating pain. The inability to open the mouth, sometimes accompanied by difficulty in swallowing, makes it hard to feed these patients. Rapid emaciation and weakness result from this condition, and also from the pain and inability to sleep. Death often occurs from spasm of the muscles that move the ribs and the diaphragm. The patient can not breathe, and is asphyxiated. If the first attack of this kind is not fatal, the second or third is apt to be so.

Chronic Tetanus.—In chronic cases there is no fever, and the contractions and spasms are limited to the jaws and to some of the muscles of the back. These cases last from four to six weeks or longer, and end in death from exhaustion, or in recovery.

The careful antiseptic treatment of all accidental wounds, however small, is the best *preventive* against this disease. When the disease has developed in the acute form, there is, with one exception, to be mentioned hereafter, no form of treatment that can save life.

Treatment.

In all cases, both acute and chronic, the patient should be kept absolutely quiet in a darkened room and protected from loud noises and draughts of air. Chloroform should be administered by inhalations to relieve the spasms, and morphine and chloral in full doses to procure sleep. The patient should be fed through a rubber tube passed into the nose and down the throat, or between the teeth, if there be space. The wound should be carefully disinfected, and any foreign bodies which it contains should be removed.

It remains to speak of a form of treatment which promises better results. It has been found that animals may be protected against tetanus in several ways. The following is one: To a culture of tetanus bacilli is added a small percentage of iodine trichloride or an extract of the thymus gland of a sheep. These substances diminish the virulence of the microbes.

Inoculation.

The fluid containing the tetanus bacilli so modified is injected, in

small but increasing doses, into some large animal—a horse or a large dog. The animal is ill for a time after each injection, but recovers. A point is finally reached when the subject of the experiment can receive large doses of virulent tetanus bacilli without suffering ill effects from it. The blood-serum of this animal acquires the property of protecting other animals from the disease, and, when injected into the tissues in large doses, *will cure tetanus that has already developed.*

Such blood-serum has been used successfully in the treatment of a number of cases of tetanus in the human being. Other ways have also been tried successfully to produce the same results. Substances have been prepared from the bacilli themselves which possess curative properties when injected under the skin of individuals suffering from this disease.

HYDROPHOBIA, RABIES, CANINE MADNESS.

Cause.

Hydrophobia is a disease caused by a specific poison the nature of which is unknown. It is almost certainly due to a microbe. In human beings it is usually contracted from the bite of a rabid animal—commonly a dog, very rarely a fox or a wolf. The poison exists in the saliva of the diseased animal. Although hydrophobia is a rare disease, the fearful nature of the malady renders a knowledge of its symptoms in the dog of some practical importance.

In all cases where a human being is bitten by an animal suspected of being mad, the latter should be confined and closely watched. Should madness fail to develop, much needless anxiety will be prevented.

Symptoms in a Dog.

In the dog the disease may be divided into three stages. During the first stage the animal shows a change of disposition, becomes dull and ill-natured, avoids his master and companions, and is very restless, wandering about in an aimless way and occasionally snapping at real or imaginary objects. Sometimes he exhibits unusual evidences of affection and tries to lick the faces and hands of his friends, thus exposing them to the danger of infection. Great thirst exists throughout the disease, and during the first stage the animal is still able to swallow and drinks with avidity.

During the second stage the animal wanders about continually with bloodshot eyes, foaming at the mouth, his head down, and his tail between his legs. He rarely goes out of his way to attack any one, but when interfered with becomes furious, and will bite at anything within reach. During this stage the animal still tries to drink, but the spasm of the throat muscles renders the act of swallowing difficult or impossible.

The third stage is characterized by exhaustion and paralysis, and ends in death.

The time between infection and the development of the disease in the dog is usually from six to twelve weeks, but it may be longer or shorter —from six days to eleven months. The duration of the disease, which almost always ends in death, is from four to ten days. In man the time between infection and the development of the disease is variable. It is usually about six weeks, but may be less, or may be extended to eight months.

Period of Incubation.

There are sometimes premonitory symptoms lasting for a few days. Itching, tenderness, and pain in the scar are sometimes noticed. The patient may suffer from depression of spirits and loss of sleep. *The true symptoms of the disease begin by a feeling of constriction and choking in the throat and difficulty in swallowing.*

Symptoms in Man.

For the progress of the disease the writer quotes from Fleming:

> The difficulty in swallowing rapidly increases, and it is not long before the act becomes impossible unless it is attempted with determination, though even then it excites the most painful spasms in the back of the throat, with other indescribable sensations, all of which appall the patient and cause him to dread the very thought of liquids. Singular nervous paroxysms or tremblings become manifest, and sensations of stricture and oppression are felt about the throat and chest. Breathing is painful and embarrassed and interrupted with frequent sighs, or a peculiar kind of sobbing movement; there is a sense of impending suffocation and of necessity for fresh air. . . . Shuddering tremors, sometimes amounting to general convulsions, run through the whole frame, and a fearful expression of anxiety, terror, and despair is depicted on the countenance.

The mouth and throat are constantly full of saliva and sticky mucus which is frequently expectorated. There is fever, and the pulse becomes rapid and feeble as the disease progresses. The mental faculties are usually clear, although there may be hallucinations of sight and hearing. The most distressing symptom is an ever-present fear of death which no amount of reassurance can influence.

Death occurs usually from exhaustion, with much difficulty of breathing, and sometimes convulsions. The average duration of the disease is four days. There is no recorded case of recovery from hydrophobia after the disease has once developed.

History.

The immediate treatment of the bite of a rabid animal consists in applying an elastic constrictor to the limb above the wound at once, and in summoning medical aid without delay. The wound and surrounding tissues should be cut out bodily. Rather less certain is the cauterization of the wound with a hot iron or with caustics, such as caustic potash, nitric acid, sulphuric acid, or some other caustic. Those mentioned are the best.

Treatment.

Of one hundred and thirty-four cases of persons bitten by animals believed to have been mad, in which the wound was cauterized, sixty-

eight escaped and forty-two died. Among cases untreated, the mortality is about sixty-six per cent.

The inoculation treatment for the prevention of rabies, as devised and practised by Pasteur, has diminished the mortality among those bitten by rabid animals to less than one in a hundred. The inoculation fluid is prepared in the following way: The spinal cords of rabbits dead of hydrophobia are dried for a certain number of days in warm air free from bacteria. The longer the cord is dried, the less the virulence of the contained virus. Emulsions of such cords are injected in gradually increasing strengths beneath the skin of the bitten individual. Thus, in the majority of cases, immunity is produced, and the disease does not develop.

SURGICAL TUBERCULOSIS.

Popular Conception.

In the popular mind the word tuberculosis is associated chiefly with consumption of the lungs, but the same microbe which produces this disease is the cause of a great number of inflammatory processes, affecting at times nearly every tissue in the body. The skin, the mucous membranes, the sheaths of the muscles and of the tendons, the various glandular organs, the lymphatics, the lining of the large body cavities, the joints, and the bones, are all very often the seat of tubercular inflammations. So widely prevalent is this disease that were tuberculosis to cease to exist, a very large part of the surgeon's occupation would be gone. Fortunately, many of these affections can be cured by surgical means. The changes produced by the tubercle bacillus are similar in character, no matter in what tissue the process is located.

The Tubercle Bacillus.

Localized tubercular inflammations regularly run a chronic course, the duration of the process extending over a period of months or of years. The action of the bacilli upon the tissues is an irritative rather than a destructive one, and results in the production of new tissue resembling in some respects the tissue formed in the healing of wounds, but differing from it in important ways. The irritation sometimes results in a pouring out from the blood-vessels of watery fluid, fibrin, and white blood cells, but the tubercle bacillus does not produce suppuration like the pus microbes. The new tissue which is produced is always poorly supplied with blood-vessels, and is very prone to undergo degeneration of a peculiar kind, known as *cheesy degeneration*, from the whitish yellow, crumbly material into which it is converted.

Tubercular Inflammations.

The way in which tubercular inflammations begin is characteristic of the disease. When one or several tubercle bacilli have been brought by

the blood or lymph current to a part and have found a lodgment in the tissues, an irritative process is started around each bacillus or group of bacilli, resulting in the formation of a little mass of tubercle tissue—the so-called *tubercle granule*—sometimes so small as scarcely to be seen by the naked eye. When newly formed, these granules are of a grey color and are translucent. Older and larger ones are often yellow, or white and opaque. Other granules form in the neighbourhood, and, when joined together, they form little masses as large as the head of a pin, or even as large as a pea. These contain tubercle bacilli and cells of various kinds held in a delicate framework of connective tissue. Around the affected area there is formed a wall of new cells which helps to stay the spread of the disease. Under favourable circumstances this layer of new cells is converted after a time into dense connective tissue, which effectually shuts in the diseased area, and by a starving-out process results in a cure by depriving the tubercle bacilli of nutriment. They live, however, for a very long time under such circumstances, often in the form of spores, and an injury, or anything which causes the barrier to give way, may set them at liberty and allow them to multiply, thus producing a relapse; or the infectious material may be carried by the lymphatics to the nearest lymphatic glands, producing tuberculosis in these structures.

Inception and History.

When the tubercle bacilli escape from a tubercular area and enter the blood current, one or several new sites of tubercular inflammation may be started in distant parts, or the whole system may be so filled with microbes that death occurs in a few weeks from the intense poisoning and interference with the functions of important organs, especially the lungs and the brain. In the majority of cases the inflammation gradually extends, invading more and more of the surrounding structures. The manner in which extension takes place will be explained in the description of tubercular inflammations of the different tissues.

As has been said, a constant characteristic of all tubercular processes is that the newly formed tissue tends to undergo degeneration and to break down into cheesy masses. The degeneration begins at the centre of each nodule and extends to its circumference.

Tendency to Degeneration.

Subsequent liquefaction of the broken-down tissues gives rise to what are called *cold* or *tubercular abscesses*. The fluid which they contain is not true pus, although it is similar in appearance. These abscesses run a chronic course. They usually spread slowly by the force of gravity and find their way between the muscles for long distances, infecting the tissues in the neighbourhood and reaching the skin often at a point far distant from the original disease. Such abscesses are not painful, and are not attended by the

Cold or Tubercular Abscesses.

signs of acute inflammation. The skin over a cold abscess is often paler than normal.

Limitation and Cure of Tuberculosis.

If an individual, the subject of a localized tubercular process, can be placed under circumstances such that the general health is improved, the resulting increased activity of the healthy tissues may cause a temporary or permanent limitation of the disease in the way already mentioned. Under such circumstances a deposit of the salts of lime may occur in the degenerated tissues. Improved local conditions, such as complete rest of a tuberculous joint, may also result in spontaneous cure.

Infection with Pus Microbes.

Occasionally infection of a tuberculous area with pus microbes may result in a rapid destruction and elimination of the tuberculous tissue, and consequently in the cure of the disease. This is true only of small lesions situated near the surface of the body, where the products of inflammation have the freest exit. When large and deeply seated tubercular areas become infected with pus microbes, the result is usually profuse suppuration of the whole infected tract and septicæmia, ending sooner or later in the death of the individual.

Media of Tubercular Infection.

As the reader will be told in *Diseases of Digestive Organs, Heart and Lungs*, infection with tuberculosis occurs most commonly in the respiratory tract. The medium of contagion is most often the dried expectoration of those suffering from tuberculosis of the lungs. Infection in the digestive tract is not rare, however, and occasionally infection takes place through the glands of the skin.

Inoculation Tuberculosis.

Inoculation tuberculosis—*i. e.*, infection through an open wound—is rather uncommon, because the tubercle bacillus grows but slowly, and the bacilli are very apt to be washed away or carried off by the wound discharge ; but such infection does occasionally occur, and gives rise to a local tubercular process which may remain as such or spread to the neighbouring lymphatic glands.

While open wounds are rarely infected with tuberculosis, minute abrasions of the skin and mucous membranes, especially about the scalp, face, and mucous membrane of the mouth, are common avenues of entrance for the tubercle bacilli. Inflamed patches of skin caused by acute or chronic eczema about the scalp and face are probably a not uncommon source of infection of the lymphatic glands of the neck. In the cases where the bacilli enter through a minute wound of the skin or through a patch of ordinary inflammation, the tubercular process usually first makes its appearance in the lymphatic glands, the bacilli being carried by white blood cells from the point of entry in the skin to these structures. The

glands, as in the case of infection with pus microbes, act as a filter to protect the system at large.

The facts in regard to hereditary and acquired susceptibility to tuberculosis will be found in *Diseases of Digestive Organs, Heart and Lungs.*

THE SYMPTOMS AND TREATMENT OF SURGICAL TUBERCULOSIS OF THE VARIOUS TISSUES AND ORGANS.

TUBERCULOSIS OF THE SKIN—LUPUS.

Tuberculosis of the skin occurs most frequently about the face and hands, but may develop on any part of the body.

The disease usually is due to direct infection through some minute abrasion of the surface or through the orifice of a gland of the skin—a pore. At the point of inoculation a small, brownish-red lump forms in the skin, varying in size from a pin's head to a split pea. Often several or many lumps appear, either successively or simultaneously. They are not tender nor painful. The inflamed skin feels firm and elastic to the touch, and is at first covered with scaly thickened epidermis.

Inception.

The process may never advance beyond this stage throughout its long course, which usually extends over a period of many years. New lumps appear near the old, and gradually a large part of the face may be invaded. Often the process heals in one place while advancing elsewhere. In a large proportion of cases the formation of these little lumps is followed by ulceration. A slowly progressive destruction of tissue takes place, which gradually advances, leaving large scars and hideous deformities in its wake. In some cases the skin alone is destroyed, in others the deeper parts are invaded, and the bones of the face may be thus extensively exposed. In some cases much new tissue is produced, causing an unsightly thickening of the parts. Each of these forms of the disease may exist alone or in combination with the others. Many of these cases die of tuberculosis of the lungs, the local process being rarely fatal.

History.

Persons who work much in a dissecting-room, and those who make post-mortem examinations, are sometimes infected with tuberculosis through minute abrasions of the fingers and hands. The disease shows itself as a slowly growing wartlike lump in the skin, of a dark red or purple colour. The centre of the lump commonly ulcerates after a time and a chronic ulcer is produced, which crusts over and discharges but little pus. The ulcerative process slowly spreads beneath the crust, and rarely heals unless the entire diseased area is removed by operation or destroyed by

Dangers of the Dissecting-room.

caustics. The disease may remain localized, or, in some cases, extensive destruction of the skin and deeper parts may result.

Treatment.

The treatment of tuberculosis of the skin is local and general. The local treatment consists in the earliest possible operative removal of the diseased tissues. Relapses are common. The general treatment consists in the administration of arsenic, iron, cod-liver oil, and other tonic drugs. The care of the general health by abundant strengthening diet, out-of-door life, baths, and other hygienic measures are important.

For a description of tuberculosis of the tongue and mucous membrane of the mouth, see *Surgical Diseases of Special Regions.*

TUBERCULOSIS OF THE LYMPHATIC GLANDS.

Tuberculosis of the lymphatic glands is a common form of the disease. In fact, a very large proportion of all inflammations of the lymphatic glands are of this character.

Location, Inception, and History.

The disease occurs most frequently between the ages of fifteen and thirty, but may occur at any period of life. The glands most often affected are those situated in the neck. The bacilli enter the tissues through some trifling abrasion of the skin of the face or scalp, or through the mucous membrane of the mouth or throat, and sometimes through the cavity in a decayed tooth. The glands of the armpit and groin are less commonly involved. The bacilli do not often cause any change at the point of inoculation, but are carried by the lymph current to the lymphatic glands, where they produce a chronic inflammation, gradually converting the gland into a cheesy mass. Direct extension to the surrounding tissues occurs late. The strong fibrous capsule which surrounds the gland usually affords for a long period an efficient barrier to the spread of the disease. When perforation of the capsule does occur, tuberculosis of the tissues in the neighbourhood is the result.

The glands first attacked are often those situated just behind the angle of the lower jaw, and from these the bacilli in most cases gain access to other glands which lie along the large muscle at the side of the neck, and to the deeper chain, which accompany the great blood-vessels on either side of the windpipe. Gland after gland is thus successively infected, and after the last gland at the root of the neck is passed, the bacilli enter the blood current and the individual may die of acute general tuberculosis. This result is fortunately not very frequent, because the process may, in some cases, remain confined to one or only a few glands, and after a time cure itself, or remain quiescent for many years.

At times the infected glands soften and form a cold abscess which breaks through the skin, leaving behind a hole. This hole remains open

for a long time and discharges a little thin yellow fluid. If infection with pus microbes takes place, suppuration of the tubercular tissue and of the surrounding healthy structures over a greater or less area ensues. If the amount of tuberculous material be small and near the surface, a rapid elimination of the tuberculous material may take place, resulting in a cure. More commonly the tubercular infection is only increased in extent.

Symptoms.

A painless, slowly progressive enlargement of one or more lymphatic glands—forming kernels, as they are called, beneath the skin, and situated in the positions above mentioned, varying in size from a pea to a mass as large as an egg (made up of many glands matted together by new inflammatory tissue)—is always suggestive of tuberculosis. A number of other diseases may resemble tuberculosis of the lymphatic glands. Only a surgeon can make a correct diagnosis of the condition.

Treatment.

The earliest possible operative removal of the infected glands offers the best and only positive assurance of a cure. When done before many glands have been invaded, and when there is no infection of the surrounding tissues, the operation is easy and almost devoid of danger. At a later period, when abscesses have formed, when all the tissues are matted together by inflammatory products, and many cheesy glands must be removed, the operation is difficult, and a return of the disease is common. The general treatment is the same as for other forms of tuberculosis.

TUBERCULOSIS OF THE BONES.

Inception.

Tuberculosis of the bones is, with the exception of tuberculosis of the lungs and lymphatic glands, the most frequent form of the disease. It commonly occurs during childhood and early adult life while the bones are growing, but no age is exempt. The ends of the long bones are especially liable to be affected. The bacilli are carried by the blood from a cheesy lymphatic gland or other source of tuberculous material and lodge in the bone, producing changes the results of which are modified by the close proximity of the disease to the joints.

The area of bone first affected may be as large as a pea. It is seldom larger than a walnut. The bacilli multiply and produce tubercle tissue in the bone, which may undergo softening and liquefaction, forming a cavity in the bone filled with a white fluid resembling pus, in which little particles of bone may be seen on inspection or felt with the fingers. Sometimes the diseased bone dies *en masse* and is found as a dead fragment of whitish-yellow colour surrounded by a layer of tubercle tissue.

If a portion of cheesy material of appreciable size is carried by the blood current from a distant part and lodges in the end of one of the long

bones near a joint, the minute artery in which the tuberculous material lodges is plugged and the portion of bone which the artery supplied becomes tuberculous and dies, forming a more or less wedge-shaped mass of dead bone, the apex of which is at the point plugged, its base directed towards or projecting into the neighbouring joint.

There may be one or several areas of disease in the same bone. Many bones throughout the body may be simultaneously or successively attacked. The former condition is uncommon. A rare but most serious condition is diffuse tubercular disease of the entire or greater portion of the shaft of a long bone.

Course of the Disease.

The subsequent course of localized tubercular inflammations in bone is variable. Spontaneous cure may take place by the enclosure of the disease in a wall of new tissue, which prevents its extension. The tubercle tissue may disappear entirely by absorption, its place being taken by a scar. Even small portions of dead bone may be removed in this way. Around such old tubercular processes a layer of condensed bone of ivorylike hardness is often formed which serves to limit the spread of the disease. More commonly the tubercle tissue undergoes degeneration and softening, the area of infection increases in size and reaches the surface of the bone, finally breaking through into the soft parts of the limb, or, what is more common and much more serious, the rupture takes place into the neighbouring joint. In the former case a cold or tubercular abscess is produced which often grows to a very large size, though the disease of the bone may be small in extent. The characteristic burrowing of these abscesses in the direction of least resistance and from the force of gravity has already been mentioned. If not opened, the abscess finally causes tuberculosis of the overlying skin and perforation, with the discharge of a white, creamy fluid containing fragments of cheesy material. The wall of such abscesses consists of a layer of soft tubercle tissue. Around the opening in the skin an elevated fringe of similar tissue is formed of a greyish-pink colour. The ease with which this soft tissue can be scraped away from the healthy parts, and its peculiar colour and relation to the surrounding skin, makes the recognition of its character easy, and serves to distinguish a *tubercular sinus*, as it is called, from any other disease. The opening, once formed, does not tend to heal, and may continue to discharge more or less tubercular material for months or years. The results of perforation into a joint will be spoken of under *Tuberculosis of the Joints*.

In the fingers and toes of young children a peculiar form of tuberculosis occurs which leads to a dilatation of the bone, giving to the finger or toe a spindle shape, as though the bone were inflated with air (*spina ventosa*). The disease rarely affects the joints, and may heal spontane-

ously, or leave some enlargement of the bone behind, or lead to the formation of a tubercular abscess and perforation of the skin and more or less complete destruction of the bone.

Symptoms.

Persons with bone tuberculosis may appear to be in perfect health, or they may be pale and anæmic. Very slight fever may be present every evening.

Pain.—Pain is usually present, but varies greatly in amount. It is increased by using the limb and is worse at night. Among children, restlessness at night, grinding of the teeth, and bad dreams are sometimes the first symptoms noticed. The pain is not always felt in the seat of the disease. Tuberculosis in the thigh bone near the hip-joint causes pain in the knee, and spinal disease often causes pain in the pit of the stomach or in the shoulders and arms. Tenderness over a bone the seat of tubercular disease is a very constant symptom, and is one of the surest signs of this condition.

Swelling.—Except when the bone is dilated as the result of disease in its interior (*spina ventosa*), there is no swelling until the bone is perforated. When this occurs a soft swelling is produced which increases slowly in size unless the tubercle tissue has undergone degeneration, in which case a cold abscess is formed. These abscesses often grow very rapidly and burrow as before described.

Redness.—Redness is absent until the skin is about to be perforated, when it presents a dusky-red or purple colour. The limb almost always becomes smaller than its fellow as the result of wasting of the tissues.

Prognosis.

The chances of recovery from bone tuberculosis are better than is the case with tuberculosis of the joints, skin, or internal organs. Spontaneous cure is possible at any time, and if the diseased bone can be removed by operation the chances of complete recovery are good, although children who have suffered from tuberculosis of the bones are apt to develop the disease elsewhere later in life.

The general treatment of tuberculosis has already been mentioned.

Local Treatment.

Complete rest for the diseased part is of the utmost importance. It may be obtained best by the use of some form of fixed dressing, such as plaster of Paris, which gives support and renders motion of the joint near the seat of the disease impossible. If the disease progresses in spite of palliative treatment, the removal by operation of the diseased tissues offers the best chance of cure. The most satisfactory results are obtained if the operation is done before the joints are involved and before the soft parts are extensively diseased.

TUBERCULOSIS OF THE JOINTS.

Tuberculosis of the joints is most often due to extension of the disease from the bones. Less commonly the lining membrane of the joint is first

affected. The structures which form the joint become the seat of tubercular inflammation, and are changed and destroyed in such a manner that the function of the joint is interfered with seriously. Some of the more important results of this interference the writer will attempt to indicate in the following pages. The details of the process are rather intricate, and must be sought for in works on general surgery.

Swelling.—Swelling in joints the seat of tubercular disease depends upon the accumulation within the joint cavity or in the surrounding parts of the products of tubercular inflammation. In one form of the disease, not uncommon in the shoulder joint, the amount of new tissue produced is small, the head of the bone degenerates and undergoes partial absorption, there is no swelling, but a diminution in size, the joint becomes stiff and painful, and the muscles about the joint wither. The process is usually very chronic.

In other cases the affected joint is swollen from the accumulation in its interior of watery fluid or tubercular pus. Such swelling may be very great.

In some cases much new tubercle tissue is produced in and about the joint, giving rise to marked swelling. This is the most common form of the disease. In these cases the thin white skin stretched over the swollen joint gave rise to the old name of *white swelling* by which this disease was known.

Pain.—Pain is always present but is a variable symptom. Some patients suffer excruciating pain with only a moderate amount of disease, while others, in whom the disorganization is more extensive, go about on the limb and suffer but little. The pain is often worse at night, and is sometimes increased by spasm of the muscles of the limb and the consequent crowding together of the diseased joint surfaces.

Deformity.—As the result of destruction of the ends of the bones, softening of the ligaments which serve to hold the bones in place, and permanent contraction and shortening of the muscles about the affected joint, deformities more or less marked are produced.

Tubercular disease of the spine destroys the integrity of the bony column. One or more of the thick solid masses of bone which form what are called the bodies of the vertebræ are destroyed, the result of which is that the portions of the spine above and below the seat of destruction fall together at an angle to fill the gap, producing a projection backward which corresponds to the loss of substance in the bones, a condition commonly known as *humped back.*

Disease of the hip gives rise to a bending upward of the thigh toward the body, the foot being at first turned outwards and at a later period inwards.

The forearm is bent upon the arm in disease of the elbow and the palm of the hand turned downwards.

Complete or partial dislocation of the diseased joints is common in the later stages of the more severe cases. The ends of the bones are partly destroyed and are changed in shape. The ligaments are weakened, and the contracted muscles pull the bones into their abnormal position, the deformity gradually increasing with time. In children the growth of the bones is interfered with, the affected limb does not increase in length as fast as its sound fellow, and the bones become more porous. They contain much fat and are soft and fragile.

Course of the Disease.

Tubercular inflammations of the joints are characterized by a chronic but irregular course. The changes in the bones and soft parts usually progress quite slowly, and there are often long periods when the disease seems to come to a standstill, or the symptoms improve greatly only to get worse again. If abscesses form and rupture, the condition of the patient becomes at once more serious, for he is now exposed to the danger of infection with pus microbes. If this occurs, all the symptoms become acute; the parts become red, hot, and swollen. Fever develops rapidly and, if the joint be large and the original abscess extensive, acute septicæmia, ending in speedy death, may be the result. More often prolonged suppuration, ending in degeneration of the kidneys and exhaustion of the vital forces, causes death after a protracted illness.

Typical Case in a Child.

A typical case of tubercular disease of the knee-joint in a child, where the disease is untreated, might be described as follows: The disease may follow a slight injury, or some severe general disease. More commonly no such predisposing cause can be discovered. The first symptom noticed is often slight lameness or pain after exercise in the affected joint. Nothing else may be complained of for weeks or months. If the knee be examined at this time, it may be noticed that the furrows which lie on either side of the knee cap are absent on the affected side. After a time the swelling, pain, and tenderness become more marked, the child holds the knee joint a little bent, and attempts to straighten it cause pain. The use of the limb for walking is attended with great discomfort, and finally its use becomes impossible. Sooner or later elastic swellings appear in the neighbourhood of the joint; the skin over the centre of the swellings becomes red or purple in colour, and is finally perforated and much tubercular pus escapes; the rupture of the abscess is followed by infection with pus microbes and a rapid change for the worse in the local trouble. The child develops a hectic fever in the afternoon, loses its appetite, emaciates and loses strength. Each new abscess is followed by symptoms of fresh infection and further loss of strength. The knee becomes more bent, and displacement of the

shin bone in a backward direction takes place. From the exhausting drain upon the system degeneration of the kidneys occurs and the child finally dies worn out.

Of course not every case has such a gloomy history. The disease may be interrupted at any time, and improvement and even cure may take place. In a certain proportion of cases, especially among children, the disease leads to obliteration, more or less complete, of the joint cavity, replacement of the tubercle tissue by new fibrous tissue, and bony or fibrous union between the bones. The joint then remains permanently stiff in a more or less favourable position. If only a part of the joint cavity be obliterated, spontaneous cure is possible with a limited range of motion; or in the most favourable cases the functions of the joint may be unimpaired. The chances of complete recovery are better among children than among adults. Persons with joint tuberculosis not infrequently develop consumption of the lungs. Acute general tuberculosis occurs occasionally as the result of an incomplete operation upon the diseased joint, or without apparent cause.

Treatment.

The general treatment does not differ from that of tubercular processes elsewhere in the body. The local treatment consists first of measures which serve to keep the inflamed joint quiet and to prevent, as far as possible, the crowding together of the diseased joint surfaces. These indications are best fulfilled by the application of some form of fixed apparatus, of which a very great variety are in use. Second, of operative measures the aim of which is to remove completely the diseased tissues or to correct deformities, or often of both objects combined.

In children the treatment of tuberculosis of the joints by means of apparatus which keep the diseased parts quiet while allowing of free movement of the rest of the body is often attended by the happiest results. Such treatment must, however, be begun early and carried out with scrupulous care for a long period. The writer can not urge too strongly upon his readers the wisdom of seeking surgical advice when a child shows evidence of trouble in a joint.

CHAPTER III.

EFFECTS OF HEAT, COLD, AND CAUSTICS.

BURNS.

Burns are caused by the action of hot substances and caustics upon the tissues. According to the duration and intensity of the action these agents produce injuries of different grades of severity which, for convenience of description, are usually divided into three degrees.

Of the First Degree.

Burns of the first degree commonly result from momentary exposure to steam, flame, or some hot fluid. The changes produced are redness and swelling of the skin. More or less intense pain is usually felt for some minutes or hours. Recovery is rapid unless a great extent of surface is burned. The outside layer of skin usually peels off at the end of a week.

Of the Second Degree.

In burns of the second degree blisters are formed on the burned surface. They may appear at once or after some hours. The blisters are filled with watery fluid sometimes tinged with blood. The outside or horny layer of the skin is raised from the surface of the true skin beneath. Such burns are caused by flame, by steam, by boiling water or other hot fluid, by strong acids, and by caustic alkalies. The pain is much more severe than in burns of the first degree, and after the blisters have ruptured the individual is exposed to the danger of infection with pus microbes through the raw surface. Under favourable circumstances the horny layer of the skin is replaced by a growth of new cells from the true skin beneath, and healing is complete in a week or ten days.

Of the Third Degree.

In burns of the third degree eschars are produced—*i. e.*, portions of the skin or deeper tissues are killed and come away as sloughs. In this class are included burns of every degree of severity, from those which cause the death of a small portion of skin to those in which an entire limb is burned to a cinder. When merely killed, not charred, the skin over the burned area is of an ashen-grey, brown, or whitish-yellow colour, and is tough, resembling parchment. The dead parts are slowly cast off from the living by the formation of a layer of new tissue at the line of separation. The process often takes several weeks for its completion. A raw surface remains, which must fill up from the bottom and edges. The skin covering for such raw surfaces is formed in a slow and tedious manner. A large burn often requires many months to heal. The resulting scars contract and often produce unsightly and troublesome deformities; the chin is sometimes drawn down on the chest, the eyelids everted, the limbs bent and

rendered partly or wholly useless. When only a part of the true skin is destroyed and islands of living skin cells are left here and there, healing proceeds much more rapidly, and the resulting scars are not so apt to cause deformity.

The gravity of a burn depends more upon the extent of surface involved than upon the depth of the injury. Burns that extend over half the surface of the body are always fatal, although they be only of the first and second degrees, and in feeble persons and alcoholics a much less extensive burn commonly ends in death.

General Symptoms of Burns.

Large burns frequently present each of the three degrees of injury to the tissues at the same time. The patient usually complains greatly of pain; is restless, throwing himself about and crying out continually. The mind is usually entirely clear at first. The pulse is rapid and feeble, and the temperature of the body below the normal. In very severe cases death may occur immediately or after some hours or a day, with the symptoms of delirium, unconsciousness, and collapse. There is usually a diminished amount of urine, which may be bloody in colour. Great thirst is a common symptom.

In less severe cases death may be postponed for a week, and then take place from pneumonia or from exhaustion and diarrhœa, accompanied occasionally by ulceration of the bowel near the stomach. If the patient lives for forty-eight hours after being burned the chances of recovery from the immediate effects of the injury are good; but the individual is still exposed to the dangers of septicæmia, erysipelas, and prolonged suppuration from infection of the burned surfaces.

Treatment.

The local treatment varies somewhat, according to the depth of the burn. In burns of the first degree, where the skin is merely reddened, the application of cold cream, or an ointment composed of carbolic acid one part, lard or vaseline one hundred parts, to the surface, usually relieves the pain speedily. Cloths wet with a strong solution of baking soda accomplish the same result.

In burns of the second degree, where blisters are produced, several forms of treatment may be employed. The best, in the opinion of the writer, is the following: The burned surface and the surrounding skin are thoroughly cleaned with soap and water and disinfected with sublimate solution, 1 to 1,000; the blisters are then removed with a scissors, and the parts dressed with clean gauze or soft clean cotton cloths soaked in a solution of ichthyol, 3 parts to 100 parts of water. This dressing, which relieves the pain more quickly than any other, should be kept constantly moist by pouring on more of the solution from time to time. It is antiseptic and under it the raw surface usually heals rapidly with little or no suppuration. The dressing may be left unchanged for several days, often

until healing is complete, and its removal at an earlier period causes but little pain.

The early treatment of burns of the third degree has for its object, primarily, the prevention of infection. To that end the parts are disinfected as above described, and the wet ichthyol dressing applied, or the dead tissues may be dusted lightly with iodoform powder and dressed with dry antiseptic gauze. When a portion of a limb is completely charred, the question of amputation must be decided by a surgeon.

To prevent, as far as possible, the deformities resulting from deep and extensive burns, surgeons employ measures of various kinds. A favourable position of the limb is maintained by the use of splints, and the healing of the raw surface is hastened by transplanting upon it portions of healthy cuticle taken from other parts of the body. By this means very extensive raw surfaces may be healed completely in two weeks, and deformities entirely prevented which would otherwise be inevitable. The cleaning and disinfection of extensive burns is best accomplished under ether or chloroform. For the pain, morphine should be given hypodermically or by the stomach, in a full dose of one quarter to one third of a grain, which should be repeated as often as necessary to keep the patient fairly comfortable. Whiskey in full doses should be given to stimulate the enfeebled heart. Hot bottles should be used if the extremities are cold. The general treatment is, in fact, the treatment of shock.

FROSTBITE.

The effects of cold upon the human body are local and general. The local effects may be divided, as in the case of burns, into three degrees.

Of the First, Second, and Third Degree.

The parts of the body most often affected are the fingers and toes, the nose and the ears. In frostbites of the first degree the part becomes white, cold, shrunken, and numb. Subsequent exposure to warmth is attended by redness, swelling, and tingling pain, which may last for some hours or days. Frostbites of the second degree are followed by marked swelling and intensely painful congestion, with the subsequent formation of blisters upon the skin. The part often remains of a dark-blue colour for a week or more. Frostbites of this degree pass without any marked distinction of early symptoms into the third degree, in which the tissues fail to regain their vitality and become gangrenous. The dark-blue colour of the skin changes after some days to a cherry-red, which grows darker, and finally turns to black. The variety of gangrene produced depends, as has already been stated, upon whether or not infection with the microbes of suppuration and putrefaction takes place.

Frostbite not severe enough to cause gangrene is sometimes followed by increased susceptibility to cold in the affected part, which may last for

a long period, each slight exposure being followed by pain, redness, and swelling. Frostbite is sometimes followed by permanent paralysis of the blood-vessels of the skin of the affected member. The skin remains permanently blue. Such a condition is occasionally observed after frostbite of the nose. Chilblains are usually the results of repeated frostbites of the first or second degrees. The toes and fingers are most commonly affected. The symptoms in mild cases are itching, pain and swelling of the affected toes. In more severe cases blisters and even ulcers may form. The pain and itching are usually most annoying on entering a warm room from out of doors, and in bed at night.

Results.

The general symptoms of exposure to extreme cold are, first, a marked stimulation of the circulation and a feeling of well-being. If the exposure be too prolonged, a sense of general pain and weariness follows, then numbness of the extremities and an intense desire to sleep. If the individual gives up to this desire, death by freezing occurs after a variable time. The entire body becomes stiff and the surface icy cold. The heart beats more and more feebly; the breathing becomes shallow. Such a condition may last for a number of hours and yet resuscitation may be possible as long as the heart has not ceased to pulsate.

General Symptoms.

Sudden exposure of a frozen or partly frozen part to a high temperature is always followed by intense congestion, and the occurrence of gangrene is thereby favoured. Therefore a very gradual return to a normal temperature should be aimed at. To this end the frost-bitten part should be rubbed with ice water and afterwards with equal parts of alcohol and water. As the circulation begins to return and the temperature of the part approaches the normal, the limb should be suspended in a vertical position, or at least elevated, to limit, as far as possible, the intense congestion and the consequent pain and swelling which are apt to occur after the circulation is re-established. During this period of reaction the limb should be covered with cloths wet with cold water, or an evaporating lotion of alcohol and water (equal parts), or with the solution of alum, sugar of lead, and water already mentioned in a preceding chapter, under *Inflamed Wounds and their Treatment*, or with the lead and opium wash (sugar of lead two teaspoonfuls, laudanum four teaspoonfuls, water one pint). After the pain and congestion have passed away the treatment will depend upon the severity of the injury to the tissues. In frostbites of the first degree no other treatment than that indicated above is necessary. When blisters form, the limb should be scrubbed and disinfected and enveloped in a dressing of dry antiseptic gauze. If the blisters are painful they may be opened before the dressing is applied.

Local Treatment.

Gangrene is indicated by a gradual change in the colour of the frozen part from dark blue to cherry-red, gradually growing darker and finally turning black, and by persistent loss of sensibility.

Gangrene.

Usually gangrene due to freezing is developed slowly, and it may be quite impossible to tell for many days whether a member will live or die. The extent of the gangrene is also hard to predict until a line of separation occurs marked by a more or less intense inflammation at the border of the living tissues. *When a limb has been so severely frozen that gangrene is thought possible, the greatest care should be used to prevent infection.* The limb should be cleaned carefully and disinfected, as before described, especial attention being paid to any abrasions of the surface. Blisters which have already ruptured should be cut away with scissors, the raw surface beneath disinfected, dried, and dusted with iodoform. The whole limb should then be covered with dry antiseptic gauze and a lightly applied bandage. This dressing should then be enveloped in cotton batting and the limb elevated. Unless fever or other sign of infection develops, this dressing should not be disturbed for a week or more.

After the formation of a line of separation, which in these cases takes place slowly, the dead parts are cast off from the living, and an ulcer is left which heals more or less rapidly according to its size and the absence or presence of infection.

Sloughing-Off.

Such ulcers may be stimulated to more rapid healing by the application to the raw surface of gauze soaked in Peruvian balsam or of powdered naphthaline. When the ulcer is large it is best treated by the application of skin grafts. When a considerable part of a limb becomes gangrenous the treatment is amputation.

TREATMENT OF THE CONSTITUTIONAL EFFECTS OF COLD.

When unconsciousness and general stiffness of the body exist, the patient should be undressed and placed on a bed in a cold room. If the breathing fails, artificial respiration should be kept up according to the method described in the article on *Medicines and Treatment.* Friction with cold water should be made upon the extremities and trunk. If the action of the heart is very feeble, whiskey may be administered by the mouth if the patient can swallow, or, if not, by the rectum, or with a hypodermic syringe. As the circulation improves, the temperature of the room should be gradually increased and warm stimulants administered, in small doses at first, and later liberally. These patients may remain in a stupid condition for several days and usually do not escape without the loss of portions of one or several limbs.

Persons afflicted with chilblains are usually not in robust health. Cod-liver oil, iron, and other tonics are therefore useful. Such persons should

wear woollen stockings and warm gloves from the beginning of cold weather. If chilblains form, the pain, swelling, and itching usually can be relieved by wet dressings of lead-and-opium wash, or of the lead-and-alum solution. Cloths wet with one of these solutions may be worn at night. Friction with an anodyne liniment is also useful. The following is a good one: Take of camphor, chloral, chloroform, and ether, of each two teaspoonfuls; laudanum and oil of sassafras, of each one teaspoonful; and soap liniment, as much as may be sufficient to make one pint. Mix the ingredients and use to rub the affected fingers or toes. When ulcers form as the result of chilblains they should be treated with antiseptic dressings.

CHAPTER IV.

INJURIES AND DISEASES OF THE BONES.

FRACTURES.

Fractures or broken bones result from mechanical violence applied to the body from without (fracture by external violence), or they are due to sudden violent contraction of the muscles of the individual (fracture

Fig. 11.—Comminuted fracture of the lower end of the humerus, caused by a fall upon the elbow.

Fig. 12.—Transverse fracture of the femur. (Stimson.)

by muscular action). The break may occur in the bone at the point where the force is applied (fracture by direct violence), or in another part of the bone, or in some other bone (fracture by indirect violence). For example, a blow upon the collar-bone breaks the bone at the point struck. The break is a fracture by direct violence. A fall upon the hand causes a

fracture of the collar-bone. In this case the force is transmitted through the bones of the forearm, arm, and shoulder-blade. This is a fracture by indirect violence. In order to save himself from falling, an individual makes a violent effort to straighten his leg at the knee. The knee-pan is torn in two by the contraction of the muscles on the front of the thigh. The fracture is the result of muscular action.

Fig. 13.—Oblique fracture of the clavicle. (Stimson.)

When a bone is broken into several small fragments the injury is called a *comminuted* fracture. According to the direction of the line of fracture with reference to the long axis of the bone, we speak of fractures as transverse, oblique, longitudinal, toothed, Y-shaped, and T-shaped. When the broken ends of the bone communicate directly with a wound

Fig. 14.—Longitudinal fracture of the tibia. (Stimson.)

Fig. 15.—Toothed fracture of the femur. (Stimson.)

Fig. 16.—Y-shaped fracture of the condyles of the humerus, caused by a fall upon the elbow. (Bruns.)

Fig. 17.—T-shaped fracture of the lower end of the femur, caused by a fall upon the knee. (Bruns.)

in the skin the fracture is *compound*. When no such communication exists the fracture is *simple*. When a fracture is accompanied by injury of important organs, large blood-vessels or nerves, or when the break communicates directly with a joint or other body cavity, it is called a *complicated* fracture. Among children and young adults in whom the bones are less brittle than in older persons, *incomplete* or *green-stick* fractures occur. The bone bends and its convex side splinters as does a green stick under similar circumstances. The concave side, on the contrary, is compressed. Another form of incomplete fracture is a simple crack or fissure in the bone, which may occur at any period of life. When one fragment is driven into the other and remains fixed in that position the fracture is called impacted.

Fig. 18.—Incomplete fracture (green-stick fracture) of the clavicle.

THE SUBJECTIVE AND OBJECTIVE SYMPTOMS OF FRACTURE.

Pain is a constant symptom of fracture. It is usually severe, and is increased by movement of the injured part. The pain is felt at the seat of fracture; but if nerve trunks are pressed upon by the displaced fragments there may be also intense pain along the course of the affected nerves. Extreme tenderness over the point of fracture is always present.

Pain and Tenderness.

FIG. 19.—IMPACTED FRACTURE OF THE NECK OF THE FEMUR. (Stimson.)

If the broken bone be grasped with the fingers upon either side of the fracture, efforts to bend the bone or to move the fragments one upon the other will reveal a point of motion where none should exist. This is a positive sign of fracture. This sign is absent in impacted fractures and in some incomplete fractures. Therefore, while its *presence* proves the existence of fracture, its *absence* does not prove that no fracture exists. By movements so directed that the broken ends of the bone are made to rub one against the other, a grating can be felt and sometimes heard. This sign is absent in incomplete and impacted fractures, and where the soft parts have slipped between the broken ends; also sometimes when the muscles have drawn the broken ends past one another, or where the muscles have drawn the fragments apart, hence its absence does not prove that no fracture exists.

Abnormal Mobility.

Crepitus or Grating.

Loss or impairment of the power of voluntary motion is a frequent sign of fracture. Fractures of the shaft of the thigh bone or of the upper arm bone are usually attended by complete inability to move the injured limb. When only one of a pair of bones is broken, as in the leg and forearm, the impairment of function is commonly not complete. The uninjured bone serves as a splint or support for the other, and the individual may still be able to walk, or to use the forearm, as the case may be. The same is true of impacted fractures. The loss of power seems to depend in part upon pain, or the fear of pain. Insensitive persons, and those who break a bone while intoxicated, not infrequently use the limb, greatly to their own disadvantage. The ends

Loss of Function.

of the bone may thus be driven through the skin and a simple fracture changed to one which is compound.

Deformity.

More or less marked deformity may be produced by the displacement of the broken fragments. The fragments may be displaced in such a way that they make an angle one with the other, the vertex of the angle being at the point of fracture. The broken ends may be pulled past one another by muscular contraction, producing shortening of the limb by overriding, as it is called. In certain instances the fragments may be pulled apart by the same means. The fragments may be displaced laterally, or one or both fragments may be rotated about the long axis of the limb, producing a twisted appearance. Several kinds of deformity may be combined in the same fracture.

Swelling and Discoloration of the Skin.

From the laceration of blood-vessels and consequent effusion of blood at the seat of fracture, from the interference with the return of blood through the veins, caused by direct pressure of the displaced fragments, and from the inflammation following the injury, swelling of the limb is produced. The swelling is most marked near the fracture. It makes its appearance soon after the injury and may increase for several days. If the fragments are not soon replaced in their normal relations the swelling is apt to be excessive. It is made much worse by improperly applied dressings. This symptom gradually subsides as healing progresses. After the bones have united and the use of the limb is resumed, a return of the swelling is common. It may persist for many months. Soon after a fracture the skin over the broken bone may become red and hot. This heat and redness usually subside after a few days if the fragments are put in good position and kept quiet. Black-and-blue marks often form in the skin of the limb, at once or after several days. They sometimes appear at some distance below the seat of fracture. They are not infrequently accompanied by the formation of blisters on the skin, filled with blood-stained fluid.

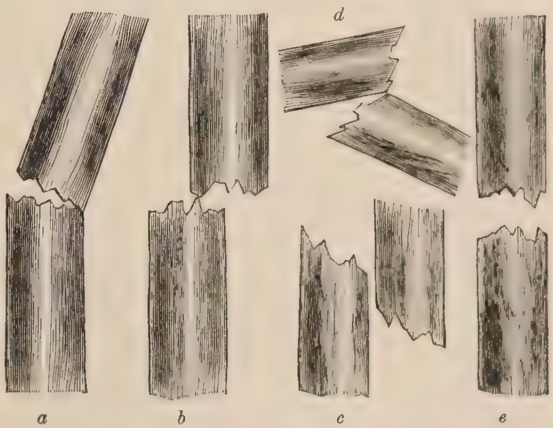


Fig. 20.—The different varieties of displacements of the fragments.

The symptoms of compound fractures are like those already described, with the addition of an open wound which communicates with the broken

ends of the bone. Sometimes one of the fragments may project through a hole in the skin. Compound fractures are serious injuries on account of the danger of infection with bacteria. When caused by crushing injuries and bullet wounds they are often complicated by extensive laceration of the soft parts and by injuries of arteries, nerves, and joints. Under careful antiseptic treatment compound fractures heal as well as simple fractures. When not so treated, infection is almost certain to take place, and the bruised tissues forming the walls of a deep cavity are in a poor position to combat the bacteria. Septicæmia, pyæmia, tetanus, prolonged suppuration with burrowing of pus, and the formation of abscesses are frequent results of such infection. Healing is delayed. Portions of the broken bone die and come away, or are removed by operation, and the individual, if he survives, passes through a long and painful illness. Even after healing is complete there is apt to be a good deal of pain and tenderness in the scar, and the injured limb regains its normal condition very slowly. Amputation is sometimes the only treatment for compound fractures with severe complicating injuries.

Symptoms of Compound Fractures.

Fig. 21.—Fibrous union after fracture of the patella. (Stimson.)

REPAIR OF FRACTURES.

The ends of the broken bones are united by a growth of new tissue from the bone itself and from the layer of tissue which immediately surrounds it—the *periosteum.* The new tissue is at first soft and fibrous, and forms a rounded mass of some size inclosing the broken ends. Gradually, as the swelling subsides, the new tissue, or callus, as it is called, becomes harder and smaller, the salts of lime are deposited in it, and when healing is complete it will have been converted into true bone. The duration of the process varies according to the size of the bone, the more or less accurate contact of the broken ends, the more or less complete immobilization of the fragments, and, to some extent, with the age and health of the individual. The thigh bone requires from six to eight weeks to unite. Both bones of the leg about the same time. The arm bone six weeks. The bones of the forearm four or five weeks. The ribs three weeks. The collar bone four weeks. The small bones of the hand two or three weeks. These statements refer to adults. In children the time required for union is shorter.

Under certain circumstances bony union does not take place, and the ends of the bone are united by a more or less extensive mass of fibrous tissue. Such union may be firm enough to make a useful limb, or it may

be so loose that the functions of the member are seriously interfered with. When the latter condition exists, it is customary to cut down upon the seat of fracture and to remove the fibrous tissue between the fragments. A thin section of bone is then sawn from the end of each fragment. Holes are drilled through the end of each piece. Through the drill holes heavy strands of catgut are passed. The fragments are brought into accurate apposition and the catgut strands are tied tightly so as to keep the bony surfaces in close contact. Firm bony union is the result of this operation. In certain situations fibrous union is the rule. Fractures of the kneepan, of the bone at the tip of the elbow (the olecranon process of the ulna), and of the narrow part of the neck of the thigh bone usually unite by fibrous tissue merely. If untreated or improperly treated, fractures usually unite with more or less marked deformity, which is permanent. The amount of new bone produced in such cases is often large, and may seriously impair the functions of the limb by pressure upon the vessels and nerves and by mechanically impeding the motions of the joints. Such bad consequences can sometimes be remedied by chiselling away the excess of bone or by refracturing the bone and restoring the fragments to their normal positions.

Fig. 22.—Deformity following Fracture of the Leg near the Ankle. (Stimson.)

Certain untoward consequences of fractures have been mentioned. There are others of more or less common occurrence. Among persons addicted to the excessive use of alcohol delirium tremens is a frequent complication. *In the writer's experience, the chances of recovery from delirium tremens following serious fractures are not good.*

Complications.

A large proportion of these patients die. It is usual to administer whiskey, liquid food, and powerful sedatives. A rare complication of fractures is the condition known as fatty embolism of the lungs. The fat from the marrow of the broken bone enters the veins and lodges in the small blood-vessels of the lungs. If such lodgment takes place in large amount, the functions of the lungs may be interfered with and the individual may die suddenly with symptoms of embarrassed breathing and shock. Gangrene may follow fracture, as the result of injury to the blood-vessels, or from undue constriction of the limb by tight bandages. Stiffness of the joints is nearly always present after fractures. It is very troublesome in the joints of the fingers after fractures near the wrist, and may be permanent in the aged.

TREATMENT OF FRACTURES.

The general rules for the treatment of fractures are to get the broken bones back into their natural positions as soon as possible, and to keep them quiet until healing is complete. To accomplish the setting or reduction of a fracture may be very easy or very difficult. The writer will endeavour to give some simple directions for the early treatment of fractures, which he hopes may be of use in the absence of a surgeon. It is well to remember that reduction can usually be effected as well at the end of a week as immediately after the injury, hence no pains should be spared to reach a competent surgeon, though several days must elapse before he can be seen.

When an individual has been injured, and it is believed that a fracture may exist, great care should be taken not to make a bad matter worse by encouraging the patient to get up or to use the limb. Before attempting to move the patient a careful examination should first be made to determine whether signs of fracture exist. The clothing should be removed if necessary to expose the injured part. This should be done with extreme gentleness, and if the attempt causes pain it is better to cut the garments in the long axis of the limb with a shears or knife. In many instances the deformity will at once reveal the presence of fracture. If not, then abnormal mobility, local pain and tenderness, and perhaps slight displacement of the fragments which may be felt with the tips of the fingers, should be looked for. All manipulations should be made slowly and gently. Where deformity is slight, it often may be appreciated at once by comparing the injured with the sound side of the body.

Examination.

Having determined that there is a fracture, it will usually be wise and often necessary to apply some form of temporary dressing which will keep the broken bone quiet and allow the patient to be moved with the least amount of suffering and danger of further injury. Where the fracture is of the upper extremity, forearm, arm, or collar-bone, there is nothing better than a triangular sling hung around the neck. If the fracture is of the upper-arm bone—the humerus—the hand and wrist alone should be supported by the sling. If the forearm or collar-bone is broken the sling should be spread out so as to support the entire forearm. The skirt of the coat may be pinned up and made to answer the same purpose. If the fracture is of the lower extremity it will be necessary to apply some artificial support to the limb to keep the fragments quiet. Such supports are called splints. They may be made from the most varied materials. Thin strips of wood of any kind, such as shingles or the sides of boxes, pieces of tin or sheet iron, wire gauze, the bark or branches of

Temporary Dressings.

trees, umbrellas, swords or guns, broomsticks, bundles of straw, pieces of stout leather, rolls of cloth, pillows, may all be utilized for this purpose. In fractures of the leg the splints should be a little wider than the limb if possible. They should be long enough to extend from the knee to a point several inches below the sole of the foot. If the injury is at or near the knee the splints should extend from below the knee to a point well up on the thigh. If the thigh is broken the splint should extend from below the foot to the armpit. Two splints should be applied in fractures of the leg—one on the outer, the other on the inner side of the limb. To prevent the injurious and painful effects of pressure, splints must always be padded with some soft material. The padding may consist of cotton, oakum, pieces of cloth, moss, grass, or any other soft material procurable. It should be applied in such a way that the point of fracture and all prominent bony points are relieved from pressure. The splints may be held in place by bandages, adhesive plaster, handkerchiefs, straps, cords, wire, or strips of cloth torn from the clothing.

Setting Fractures.

Before applying the splints it is well to try and put the bones back into their normal relations—in other words, *to set the fracture.* There are various obstacles which may make this difficult, among them the interposition of the soft parts between the fragments and the contraction of the muscles, or the fragments may be impacted. To overcome the action of the muscles, which tends always to keep the fragments in their unnatural position, we employ extension and counter-extension and coaptation of the broken ends. The meaning of these terms is simply this: The limb is grasped below the point of fracture and pulled upon steadily and strongly in the line of its long axis. This is called making extension. Some one else grasps the limb above the fracture and pulls in the opposite direction. That is called making counter-extension. After a few seconds or a minute the muscles of the limb become tired, and frequently the broken bone slips easily into place. If it does not, we may employ coaptation of the fragments—*i. e.*, while the limb is pulled upon, a third person tries by direct pressure upon the broken ends to bring them into place. These measures are often successful. They should be employed gently and without hurry. If they do not succeed there is probably some obstacle to reduction which will require the knowledge of a skilful surgeon to overcome.

Application of Splints.

The padded splints should be ready before the attempt at reduction is made, so that they may be applied at once as soon as the bones are in place, lest the displacement recur while the splints are being prepared. The splints should be laid against the outer and inner sides of the limb, and while being held in position a second person should bind them firmly to the limb with bandages, handkerchiefs, or other material. No bandage should be ap-

plied beneath the splints to a freshly-broken limb, for fear of strangulation. No direct pressure should come upon the seat of fracture. The limb should not be constricted at any point. In fractures of the thigh the splint should be applied to the outside of the limb, and should extend from below the foot to the armpit. The outside of the ankle should be well padded and the foot bound to the splint so that the limb cannot rotate on its long axis. In order to be of any service in retaining the broken bone in position the splint must be bound in place while extension is made on the foot. A second splint may be applied to the inner side of the limb in fractures of the middle of the thigh bone. It may extend from the knee to the groin.

TREATMENT OF COMPOUND FRACTURES.

Arterial hæmorrhage should be stopped by pressure, according to one of the methods already given. The skin of the limb and the wound should be cleaned and disinfected superficially and covered with a dressing of antiseptic gauze. If the deformity be great it should be remedied according to the preceding directions. The upper extremity should be supported by a sling, the lower extremity by splints. If the materials necessary for thorough disinfection are not at hand it is far better not to interfere with the wound in any way. *Infection will surely be followed by the most disastrous results.* Allow a clot to form on the wounded surface and protect it with clean towels or handkerchiefs; otherwise leave it alone.

Prompt Attention.

The popular impression that fractures are injuries requiring the prompt attention of a surgeon has its foundation in fact; and in truth no branch of surgical art requires more technical skill and judgment for its successful practice. With this caution the writer offers the following suggestions for the treatment of fractures of special bones when no surgeon can be reached. The proper treatment of many forms of fracture is of course quite out of the question without previous surgical training:

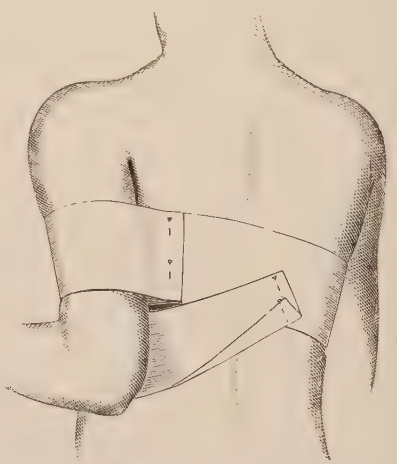


FIG. 23.—THE FIRST STRIP.

FRACTURES OF THE COLLAR-BONE.

The collar-bone is more often broken than any other bone in the body. Fracture is caused in the largest number of cases by indirect violence, such as falls on the shoulder,

elbow, or hand. The usual situation of the fracture is near the middle of the bone. The local deformity is easy to see and to feel, and often easy to overcome by lifting the shoulder outwards, upwards, and backwards. The fragments are sometimes very hard to keep in place, but

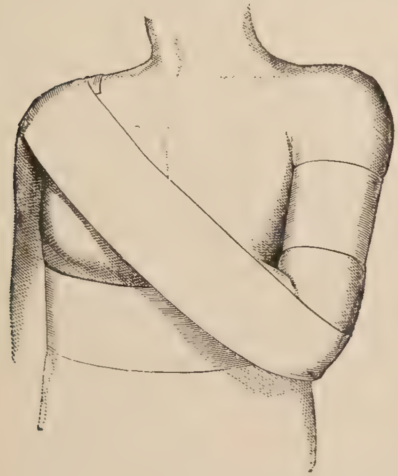


FIG. 24.—SAYRE'S DRESSING FOR FRACTURED CLAVICLE. (Front view.)

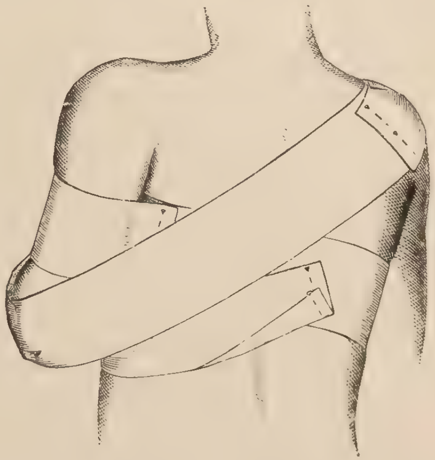


FIG. 25.—SAYRE'S SECOND STRIP FOR FRACTURED CLAVICLE. (Back view.)

the displacement rarely gives rise to serious disability. A good dressing is that of Sayre. (See Figs. 23, 24, 25.) The bands are made of heavy adhesive plaster—not rubber plaster. The latter causes marked irritation of the skin when used in this manner. A bandage round the body, including the arm of the injured side, and a sling for the forearm, are often the only dressing necessary. Bony union occurs in about four weeks.

FRACTURES OF THE RIBS.

Causes.—Direct or indirect violence, rarely muscular action (violent coughing).

Symptoms.—Pain in the side, increased on drawing a deep breath; local tenderness, sometimes mobility and grating of the fragments, and, if the lung is ruptured, cough and spitting of blood. Occasionally crackling of the tissues on pressure over the ribs near the fracture, from air beneath the skin.

Treatment.—A band of rubber plaster eight inches wide tightly applied round the entire chest to limit the motion of the ribs. It should be put on while the lungs are emptied as far as possible of air. Or a broad roller bandage applied in the same manner. Morphine or opium to relieve the cough and pain. Union of the fragments in three or four weeks.

FRACTURES OF THE HUMERUS—THE BONE OF THE UPPER ARM.

Delayed union or failure of union is more common than after fracture of any other bone. The break may occur near the upper end of the bone, in the shaft, or at the lower end. Direct or indirect violence, rarely muscular action (throwing a stone), is the cause.

Of the Upper End.

Fractures of the upper end may occur in one of several situations. A practical knowledge of anatomy is necessary for the recognition of these varieties. In the commonest form the fracture takes place outside the joint. The upper end of the lower fragment lies to the inner side—*i. e.*, is displaced towards the armpit. There is complete loss of power in the arm, pain and tenderness. If the upper end of the bone be grasped between the fingers of the left hand and gentle rotary movements of the arm be made with the right hand, which grasps the elbow, it will be appreciated that the upper end of the bone does not move with the shaft. Grating of the fragments can also be felt in some cases. Reduction can usually be effected by extension and coaptation. A sling which supports the wrist forms a good temporary dressing; in addition a folded towel may be placed in the armpit and the limb bandaged to the body. Union in five or six weeks.

Of the Shaft.

Fractures of the shaft of the bone usually give all the signs of fracture, and are easy to recognise. The temporary dressing may be the same as for fractures of the upper end of the bone.

Of the Lower End.

Fractures of the lower end of the bone are serious on account of the interference with the motions of the elbow joint which may remain after union is complete. The exact nature of the injury is sometimes obscured by swelling. The lines of fracture vary in different cases. Among the commoner varieties are the following: 1st. The wide lower end of the bone is broken square off—*i. e.*, the line of fracture is transverse. The lower fragment and the forearm are displaced backwards. The relations between the bone at the tip of the elbow and the bony prominences on the outer and inner sides of the lower end of the humerus are preserved. In dislocations of the elbow these relations are altered. The normal relations can be seen on the uninjured side. 2d. In addition to the transverse fracture, the lower fragment is divided into two pieces vertically. This is known as a T-shaped fracture, from the resemblance of the lines of fracture to a capital letter T. 3d. The lines of fracture resemble a capital letter Y. The fracture enters the joint in both the T-shaped and Y-shaped varieties. 4th. One or other of the bony prominences which project at either side of the elbow is separated from the shaft of the bone. The line of fracture may or may not enter the joint. A sling to support the forearm is a good temporary

dressing. The permanent dressing of these fractures can hardly be made except by a surgeon.

FRACTURE OF THE TIP OF THE ELBOW.

Fracture of the olecranon process of the ulna (the bone which forms the prominent tip of the elbow) is rather rare. The cause is usually a fall upon the elbow. The upper fragment is pulled away from the lower one by the action of the large muscle at the back of the arm. There is inability to straighten the elbow joint actively.

Treatment.—In order to keep the fragments in contact, the limb must usually be kept in an extended position at first—*i. e.*, the elbow not bent. A long splint along the front of the limb is generally used to accomplish this result. After ten days or two weeks the elbow may be bent to some extent and kept so. It is thought that the subsequent stiffness of the joint is less when this practice is followed. Union is nearly always fibrous. Failure of union is treated by sewing the fragments together.

FRACTURES OF THE BONES OF THE FOREARM.

The bones of the forearm may be broken in any situation by direct or indirect violence. If the bones are broken at or near the same level the deformity is commonly marked.

Of the Lower End of the Radius.

A very common fracture (Colles's fracture) is that of the lower end of the radius, the bone which lies upon the outer or thumb side of the limb. The lower fragment is tilted backwards and the hand is displaced slightly to the outer side, producing what is called the silver-fork deformity. After reduction has been effected by extension and direct pressure upon the broken ends, the forearm should be placed between two splints, one on the back, the other on the front of the limb. The splints should extend from the vicinity of the elbow to the base of the fingers. The forearm should be bent at right angles to the arm, and the thumb should be directed upwards while the splints are being applied. Care should be taken that the inside splint is not too long so that it presses on the tissues at the bend of the elbow. The splints should be as wide as the widest part of the forearm, a sling used to support the limb, and the patient encouraged to move the fingers frequently so that the joints may not become stiff.

FIG. 26.—SILVER-FORK DEFORMITY IN FRACTURE OF THE LOWER END OF THE RADIUS (COLLES'S FRACTURE). (Stimson.)

Of the Bones of the Hand nearest the Wrist.

Fractures of the bones of the hand nearest the wrist can usually be recognised by the deformity, a more or less prominent lump or an irregularity of outline on the back of the hand being present in most cases. After reduction by extension and pressure the fingers may be closed over a roller bandage or any other firm cylindrical body of suitable size placed in the palm and bandaged in this position.

FRACTURES OF THE BONES OF THE FINGERS.

Fractures, when occurring in the first bone next the hand, may be treated as above. Fractures occurring in the second and third bones of the fingers may be treated by bandaging the finger to a straight splint placed on its palmar surface, extending back to the junction of the finger with the hand. The splints should be worn for about five weeks in fractures of the bones of the forearm, for two or three weeks in fractures of the bones of the hand and fingers.

FRACTURES OF THE THIGH BONE OR FEMUR.

The bone may be broken near its upper end, in the shaft, or near its lower end. Fractures near the upper end occur frequently among elderly people, oftener in women than in men. Falls upon the knee or hip are common causes. Owing to the fact that the bones of the aged are very porous and therefore very brittle, these fractures sometimes occur as the result of very slight degrees of violence, such as a stumble or a misstep. The break takes place in the constricted portion of bone known as the neck, which joins the head to the shaft of the femur, or at the junction of the shaft with the neck. The fragments are sometimes impacted.

Symptoms and Prognosis.

Pain, inability to raise the limb from the ground when the patient lies upon his back, shortening of the limb, and sometimes grating of the fragments characterize this fracture. The whole limb is usually rotated outwards so that the toes of the injured limb point away from the median line of the body. The injury is a very serious one on account of the advanced age of these patients, who bear confinement to bed very badly. Death is not uncommon during the first three weeks following the injury, from exhaustion and pneumonia. The chances of bony union when the fracture is through the narrow part of the neck of the bone are not good, hence impaction is a favourable circumstance. When the fracture takes place at the junction of the shaft with the neck, bony union is the rule. In any case, much stiffness at the hip joint, a permanent limp, and marked disability are regular consequences of the injury. Even if no union occurs between the fragments, the patient may still have a useful limb. Very strong

ligaments pass from the bones of the pelvis to the upper part of the thigh bone, and upon these the weight of the body is sustained.

Treatment. Abundant food, stimulation, careful nursing, cleanliness, and the prevention of bedsores are the first indications for treatment in these cases. The patient should lie upon a smooth, firm bed. It is customary to make permanent extension upon the limb by means of a weight and pulley in order to diminish the shortening. A short description of the apparatus used will be found under *Fractures of the Shaft of the Femur*. If the patient bears confinement well, extension may be continued until some union has occurred—for six weeks or more. If the strength fails, some form of fixed dressing, such as plaster of Paris, may be applied to the limb, including the pelvis, and the patient got out of bed on crutches as soon as possible. Other means have been devised to obtain bony union and better results in fractures of the neck of the femur. The fragments have been brought into apposition and nailed together in a few cases. A special apparatus has been devised to keep the bones in contact by means of a firm pad and screw pressure applied on the outer side of the hip. These methods have given good results in some cases.

FRACTURES OF THE SHAFT OF THE FEMUR.

Causes, direct or indirect violence. The line of fracture is usually oblique. There is often over-riding. The lower end of the upper fragment sometimes projects forwards, and may perforate the skin on the front of the limb. The diagnosis can often be made on sight from the deformity. Gentle movements of the limb always show abnormal mobility. The limb is shortened.

Treatment. The application of a long splint on the outer side of the limb has already been spoken of as a temporary measure. The permanent dressing must be made by a surgeon. Two forms of dressing are in general use. In one, the whole limb, including the pelvis, is encased in plaster of Paris soon after the injury. Extension is made on the foot while the dressing is being applied. With this form of dressing the patient may get about on crutches after ten days or a fortnight. The other form of treatment, which gives more certain results, consists of continuous extension and coaptation.

Extension. Extension is made by means of two strips of heavy adhesive plaster which are laid along the outer and inner sides of the leg and thigh from a point somewhat above the seat of fracture to a few inches above the ankle. The strips are heated, laid upon the skin, and covered with a bandage. The lower ends of the strips are carried down beyond the foot and fastened to the ends of a stick of wood which is longer than the sole is wide, and serves to prevent pressure

upon the ankle bones. To the centre of the stick a cord is fastened, which passes through a pulley at the foot of the bed. To the end of the cord a weight is attached. The foot of the bed is raised a few inches on blocks,

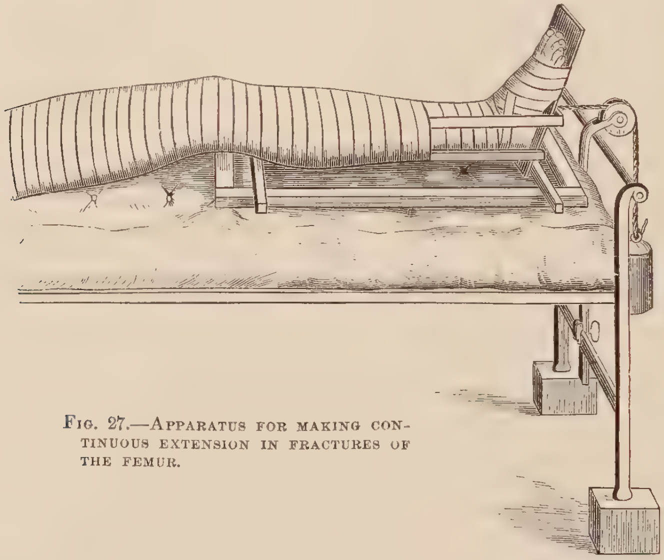


FIG. 27.—APPARATUS FOR MAKING CONTINUOUS EXTENSION IN FRACTURES OF THE FEMUR.

so that the body furnishes counter-extension. The weight varies from five to twenty pounds, and is regulated by the size of the patient and the persistence of the shortening.

Coaptation is obtained by numerous thin strips of wood well padded and bound about the circumference of the thigh at the point of fracture.

Coaptation.

To overcome the tendency to rotation of the fragments about the long axis of the bone, the leg is laid upon a board or framework having at its lower end a vertical foot-piece, to which the foot of the patient is bound with bandages. The board slides upon a little track, upon which it rests in the bed. This apparatus, when properly applied, is comfortable and gives good results. The shortening in uncomplicated cases rarely exceeds an inch. The extension is usually kept up for a month or six weeks, or longer when necessary. Union is usually firm in from six to eight weeks.

In all injuries of the lower extremity which confine the individual to his bed, it is important that the injured part should be relieved from the

Screen for Bedclothing.

pressure of the bedclothing. In order to accomplish this an arched framework of wire or wood may be used to maintain a space above and around the limb. Such a framework is shown in Fig. 28. Something which answers the purpose very well can be made from three straight sticks of wood and several barrel hoops taken from a flour barrel.

This framework is not simply used to make the patient more comfortable, but for more important reasons. When a patient lies in bed continuously for a long period, and especially where he is weak and cannot change his position from time to time, but must lie upon his back pretty constantly, from this or other causes the feet tend to fall downwards and forwards from their own weight, so that the sole of the foot looks directly backwards and the back of the foot forms a straight line with the front of the leg. If this position is maintained for several weeks, it may become difficult or impossible to bring the foot at right angles to the leg, the muscles on the back of the leg become shorter, the ankle joint becomes stiff, and when the individual has recovered and tries to walk, it is found that the sole of the foot can no longer be applied to the ground. This is a most annoying result, which should always be foreseen and guarded against by relieving the limb from pressure and by supporting the soles of the feet against pillows or a padded block at the foot of the bed.

Object.

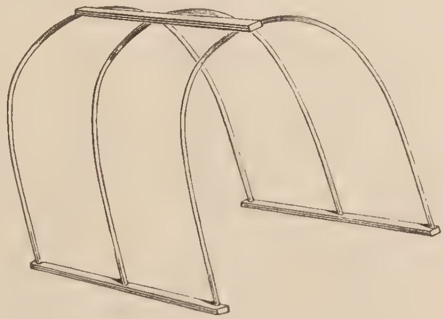


FIG. 28.—WIRE OR WOODEN SCREEN TO KEEP THE BEDCLOTHING FROM RESTING UPON FRACTURED LIMBS.

Fractures of the lower end of the femur are serious, from the proximity of the knee joint, which is often injured. There is sometimes much splintering of the fragments, and the fracture is not infrequently compound. The treatment is continuous extension where that is applicable. In some cases a good deal of difficulty is experienced in keeping the fragments in position, and resort must be had to other apparatus of various kinds—suspension of the limb with an anterior metal splint, the double inclined plane, plaster-of-Paris dressings, and others. For a description of these apparatus the reader is referred to works on fractures.

Of the Lower End of the Femur.

FRACTURE OF THE KNEE-PAN.

Fractures of the knee-pan or patella are usually the result of muscular action, occasionally of direct violence. In the former variety the patient stumbles or falls, makes a violent effort to save himself, and the patella is fractured as the result of the contraction of the muscles of the front of the thigh. The fracture is usually transverse, and the fragments may be separated one or more inches by the continued traction of the muscles upon the upper fragment.

At the time of the accident the patient feels a sharp pain in the knee,

and perhaps hears the bone snap. There is complete inability to straighten the leg at the knee, and the separated fragments can easily be felt and moved independently of one another. Soon after the accident there is commonly an extensive effusion of blood into the knee joint, marked swelling, and ecchymosis (black and blue). Union is most often fibrous, with a greater or less separation of the fragments. Close fibrous union is, however, not uncommon, and bony union has been observed. In the majority of cases of simple fracture, when properly treated, the functions of the knee joint are but slightly impaired. When the splints are discarded and the patient begins to use the limb, at the end of eight weeks or more, there is always much stiffness of the joint. This diminishes with time and use, and after some months may disappear entirely. Even when the fibrous band which joins the fragment is quite long, extension of the knee can usually be performed in a satisfactory manner.

Symptoms and Prognosis.

The limb should be placed on a padded splint as wide as the thigh and long enough to reach from a point just above the heel to the fold of the buttock. The splint should be secured to the limb by bandages. During the first few days following the accident it is often necessary to limit the effusion into and the inflammation of the knee joint by the application of cold, in the form of an ice bag laid over the knee, the limb being kept quiet on a posterior splint meanwhile.

Temporary and Subsequent Treatment.

As soon as the swelling and inflammation have subsided somewhat, the aim of the treatment is to bring the fragments as nearly as possible into contact, and to obtain close union between them. This can be

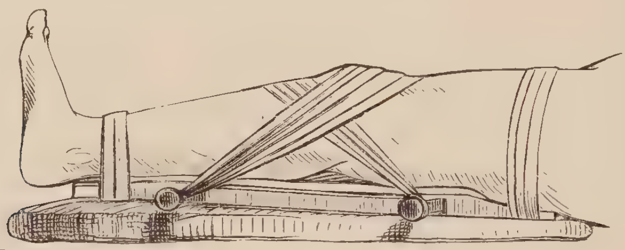


FIG. 29.—AGNEW'S SPLINT FOR FRACTURE OF THE PATELLA. (Agnew.)

accomplished more or less successfully by a number of devices, some of which act directly, such as hooks which are inserted into the fragments and approximated by means of a screw. These are seldom used at present. Other appliances act through the medium of the soft parts, such as strips of adhesive plaster or elastic, which are applied above and below the fragments and are fastened to a splint behind the limb. (See Fig. 29.) There are many other forms of apparatus which depend upon the same principle. They are nearly all effective.

When the fragments cannot be brought together on account of a great effusion of blood into the joint, or when one is tilted so that its broken surface cannot be brought against the broken surface of the other, or when the soft parts fall between them, the treatment is to open the joint freely by a transverse cut across its front, to wash out the blood clots, pare the broken surfaces, and sew the fragments together with catgut. The results of this operation are excellent. Bony union is obtained. It should be done only when the most perfect antisepsis is attainable. Failure in this respect means suppuration of the joint and permanent stiffness of the knee as the most favourable result, or amputation of the thigh to save the patient from death by pyæmia or septicæmia in less favourable cases.

FRACTURES OF THE LEG.

There are two bones in the leg—a large one, the shin bone, or tibia, and a smaller one, the fibula. Either may be broken alone, or both together.

Fracture of the Ends of the Tibia.

Fractures of the tibia may occur at either end or in the shaft of the bone. Fractures of the upper end are sometimes serious on account of complicating injuries to the knee joint. The temporary treatment may consist of lateral splints or a long posterior splint. The permanent treatment is varied to suit the individual case. It may consist of permanent extension, a posterior splint, or a plaster-of-Paris dressing.

Fracture of the Shaft of the Tibia.

When due to indirect violence, fractures of the shaft of the tibia occur most often at the junction of the middle third with the lower third of the bone. The fibula rarely escapes fracture at the same time. It is usually broken at a higher level than the tibia. The line of fracture in the tibia may be transverse, oblique, or V-shaped. In the last case a sharp point exists at the lower end of the upper fragment, which may perforate the skin. Reduction may be accomplished by extension and counter-extension. It is not always easy. The nature of the injury is not difficult to recognise, all the signs of fracture being commonly present.

Temporary and Permanent Dressing.

The temporary dressing consists of lateral splints, applied as already described. The permanent dressing may consist of apparatus of various kinds. The most popular dressing in New York city at the present time is the plaster-of-Paris splint. This may be applied in such a way as to surround the limb partly or wholly. In the latter case, if applied directly after the injury, the fracture is reduced and the limb covered with a thick layer of cotton batting, over which the plaster is applied in the following manner: Roller bandages of gauze or crinoline are prepared by rubbing dry plaster thickly into the meshes of the cloth as the bandages are rolled ;

when wanted for use, one or two bandages at a time are immersed in cold water until thoroughly wet; the water is then squeezed out and the bandage applied like an ordinary roller. *No tension should be put upon the bandage as it is rolled about the limb, lest undue constriction be produced.* After several layers have been applied, the surface of the bandage is wet and dry plaster rubbed in with the hand. The splint is carefully supported until the plaster is firm, which should be in a few minutes if the plaster is fresh and of good quality. This dressing should extend from the toes to the knee or above it. If the toes get blue and cold the bandage is too tight, and must be cut down the front with a knife at once. If, as the swelling of the limb subsides, the splint gets loose, it is replaced by another, applied without padding. These fractures require from six to eight weeks to unite. The ankle is left stiff for some time, and the leg usually swells and remains blue and tender for many months. Annoying eczematous eruptions often occur on the skin of the limb, and neuralgic pains are not uncommon. Some of these annoying results may be modified by daily douching of the limb first with hot and then with cold water, by massage and bandaging. These measures are useful in the after-treatment of all fractured limbs.

Fig. 30.—Plaster-of-Paris dressing in fracture of the leg.

Pott's Fracture.

The commonest fracture of the lower part of the leg is known as Pott's fracture. The cause is a sudden violent wrench of the ankle outwards. The fibula is broken near its lower end. The tibia is broken near the pointed tip of its lower end. The tibia and fibula are often separated from one another and a small portion of the tibia torn off where it is attached to the fibula. The entire foot is displaced outwards. This is a serious fracture. It is easy to recognise from the outward displacement of the foot and the prominent edge of the lower end of the tibia, which can be seen and felt beneath the skin at the inner side of the ankle. (See Fig. 31.)

The temporary treatment may consist of side splints. The success of the permanent treatment depends upon the completeness with which reduction of the displacement is effected and maintained. To accomplish

and maintain reduction may be very difficult, as the many bad results following this fracture bear witness. When reduction has been effected (best under an anæsthetic) a plaster-of-Paris dressing is usually applied. The entire foot must be pushed strongly inwards and held at right angles to the leg while the plaster is applied. The dressing should extend from the toes to the knee. Union is firm in from four to six weeks. If perfect reduction has been maintained the functional result is excellent, otherwise the sole of the foot looks outwards. The point of support upon which the weight of the body rests is out of line, and a painful and permanent deformity is the result.

Treatment.

FIG. 31.—DEFORMITY IN POTT'S FRACTURE. (Stimson.)

FRACTURES OF THE NOSE.

The bones forming the bridge of the nose are the most frequent seat of the fracture. The cause is direct violence. The injury may be associated with fracture of the base of the skull.

The symptoms of fracture of the nose are pain, tenderness, and deformity. The fragments are displaced backwards and to one side. Bleeding from the nose may be present. In some cases a considerable amount of blood may be lost, but dangerous hæmorrhage is very rare. Sometimes air is forced into the tissues of the eyelids and cheeks through rents in the mucous membrane of the nasal cavity during violent blowing of the nose after the injury.

Symptoms.

If there is no displacement the treatment consists in syringing out the nasal cavity frequently with a weak solution of salt in boiled water, or with a solution of boric acid in water (1 to 50). The syringing should be done with a small glass syringe, very gently. Displacement should be corrected by introducing into the nose through the nostril a small smooth steel instrument and prying the bones into place, using the fingers of the left hand to mould the fragments from the outside. A strong hairpin might be used for this purpose. Reduction may have to be repeated several times on successive days. No external dressing is of any use to prevent the recurrence of displacement. Excessive swelling of the nose may be treated by wet dressings of ichthyol, or of alum and sugar-of-lead solution. Excessive bleeding may be stopped by plugging the nostril with a strip of gauze or with a narrow strip torn from a handkerchief. Union is complete in from two to three weeks.

Treatment.

FRACTURES OF THE LOWER JAW.

Fractures of the lower jaw are caused by direct violence. The break most often occurs in the middle line in front, or to one side, near the middle line. Fractures near the back teeth or behind the teeth are less common.

Symptoms.

Pain, usually bleeding from the mouth, deformity, recognised by irregularity in the line of the teeth, and inability to bring the teeth together, are present, together with abnormal mobility, which can be appreciated by grasping the fragments on either side between the forefingers and thumbs, the fingers on the teeth, the thumbs under the chin, and trying to move the fragments in different directions.

Treatment.

When there is no displacement (Fig. 32), a bandage, such as is shown in the cut, suffices to keep the fragments quiet. A fluid diet and scrupulous attention to the cleanliness of the mouth are necessary. A cheap and effective mouth wash for this purpose is a solution of permanganate of potassium in water (1 to 1,000). It should be used every two hours. The gums and teeth should be cleaned mechanically several times a day with swabs of cotton twisted around the end of a small stick and moistened with the above solution. When much displacement exists which tends to recur, the best treatment is an interdental splint of hard rubber or some similar material. These splints are made by dentists. A cast of the teeth of both jaws is made in plaster of Paris. From this cast an exact model of the teeth of both jaws is obtained. Upon this model the dentist constructs the splint, which consists of a piece of hard rubber containing upon its upper surface an impression of the upper teeth and upon its lower surface an impression of the lower teeth. The impressions represent the normal relations of the teeth of both jaws. The displacement is reduced and the splint is put into the mouth and adjusted so that each tooth fits into the impression made to receive it. A bandage beneath the chin holds the lower jaw firmly against the splint. A hole is left in front, through which liquid food may be introduced through a rubber tube. The results of this form of treatment are excellent. Union occurs in four or five weeks.

Fig. 32.—Four-tailed bandage for fracture of the lower jaw. (Stimson.)

FRACTURES OF THE SPINE.

Fractures of the vertebræ—the bones forming the spinal column—are comparatively rare. They may be produced as the result of direct or indirect violence, very rarely by muscular action. A violent forward bending of the spinal column, such as results from the fall of a heavy stone or a portion of a wall upon a workman's back while he stands in a slightly stooping posture, is one of the ways in which these fractures occur. The break may be in any part of the back. There are two situations in which a larger proportion of fractures occur than elsewhere. These are at the junction of less flexible parts of the spinal column with those which are more flexible—namely, in the lower part of the neck and low down in the back, just below the last rib. In a general way, the higher up in the spinal column the fracture occurs, the poorer the chances of recovery. The spinal cord may be completely crushed by the edges of the displaced bones. It may be merely compressed by a portion of bone or a blood-clot, or—rarely—it may be uninjured. In a certain proportion of cases, when the injury is situated high up in the neck, death is instantaneous from paralysis of the muscles of respiration. In other cases, when a lower portion of the cord is injured, life may be prolonged for a longer or shorter period. When the spinal cord is not seriously injured, recovery, complete or partial, may take place.

Symptoms.

Paralysis of motion and sensation in those parts of the body supplied by the nerves given off from the spinal cord below the point at which it is injured is regularly present. Local deformity can sometimes be felt in the back. There may be a projection or a depression of the broken vertebræ. There is sometimes angular deformity. The rectum and bladder are usually paralyzed, producing retention of urine and incontinence of fæces. If the patient survives for a few days or weeks, bedsores and inflammation of the paralyzed bladder are apt to develop. Improvement is announced by tingling pains in the legs and by a change for the better in the condition of the bladder and rectum. Return of active motion in the limbs occurs later if at all.

Treatment.

The greatest care should be used in moving and transporting these patients, lest the injury to the spinal cord be increased. The back should be supported during transportation by cushions or pillows, or bags filled with sand, and all movements of the patient should be made with extreme gentleness. The subsequent treatment consists in putting the patient upon a water bed, to prevent, as far as possible, the formation of bedsores, in attention to the bladder, and in scrupulous cleanliness. The operative treatment of these cases, by cutting down upon the spine in the back and elevating or removing the depressed fragments of bone and blood-clots which may be pressing upon the cord,

has been attended with good results in a few cases. If actual destruction of the cord exists, no improvement can be expected as the result of operation. In some cases, efforts to remedy the displacement of the bones by extension and counter-extension made upon the head and legs and direct pressure upon the broken vertebræ have been attended by good results. The effort should only be made by a surgeon. A plaster-of-Paris jacket may be applied subsequently.

ACUTE SUPPURATIVE INFLAMMATION OF THE BONE.

Causes.

As the result of infection with pus microbes, acute suppurative inflammation of bone may follow compound fractures, amputation wounds, and wounds of the soft parts in which a surface of bone is or is not exposed. The treatment of these conditions is, in general, the treatment of inflamed wounds. One form of acute inflammation of bone, which occurs rather frequently and the early recognition of which is of great importance, since the life of the patient may depend upon prompt and efficient treatment, is caused by infection of the marrow of the bones with pus microbes. It occurs nearly always during the period when the bones are growing, and often attacks primarily the lower part of the thigh bone and the upper part of the shin bone, although many bones throughout the body may be affected at the same time. The inflammation of the bones sometimes follows severe general diseases, such as typhoid fever, measles, scarlet fever, diphtheria, or small-pox. Sometimes exposure to cold and wet, overfatigue, or a slight bruise over the bone are the only causes apparent. Occasionally the attack is preceded by bronchitis or diarrhœa. Of course none of these causes alone are sufficient to produce the disease without the localization of the pus microbes in the bone, and we must suppose that in some cases, at least, the diseased conditions which precede the bone inflammation have allowed the entrance of the bacteria into the circulating blood, or have produced a condition of diminished resistance in the tissues in which the bacteria develop, or that both these results have been produced.

History.

The local process in the bone consists of a rapid growth of pus microbes in the bone marrow, the formation of pus, and a more or less rapid extension of the purulent inflammation throughout the whole or greater part of the marrow cavity. Subsequently the pus finds its way to the surface of the bone; from this point the inflammation spreads beneath the layer of tissue surrounding the bone—the periosteum (from which the bone derives much of its nutriment)—in every direction. Thus the entire shaft of a long bone may be bared of its surrounding envelope of periosteum. The soft parts of the limb are next invaded, and very large abscesses are often produced. The neighbouring joint often becomes the seat of suppurative inflammation.

By the action of the poisons produced by the pus microbes, and from the interference with the circulation and consequently with the nutrition of the bone, due to intense congestion, and from the separation of the periosteum, necrosis or death of the bone occurs. The necrosis may involve the entire shaft of the bone or only a part. Sometimes the layer of cartilage which lies between the shaft proper and the expanded end of the bone which forms a part of a joint is destroyed by suppuration. The end is thus separated from the shaft. This accident may result in an interference with the subsequent growth of the bone. Pyæmia, resulting from the purulent inflammation of the veins within the bone and the production of infective clots which soften and are carried to other parts of the body, is one of the ways in which a fatal result is sometimes produced.

Symptoms.

In the most severe cases the disease runs its course very rapidly, death occurring within a few days. These patients usually have a chill, followed by high fever, great prostration, delirium, stupor, coma, and death. The nature of the disease is often not recognised during life. In less severe cases, the chill, fever, and prostration are followed by pain of an intense boring, throbbing character in one or more of the extremities. The power of voluntary motion is lost in the affected limb, and passive movements are attended by an increase of pain. During the early stages of the disease, and until the soft parts surrounding the bone are invaded, swelling of the limb and redness of the skin are commonly absent. A most important sign during the first few days of the disease is the presence of extreme tenderness over the affected bone, the centre of which corresponds to the centre of the inflammatory process. As soon as the inflammation reaches the surface of the bone, which event usually occurs after a week or more, an accumulation of pus forms between the bone and the periosteum, the limb swells, and the periosteum finally ruptures, allowing the pus to escape into the soft parts of the limb. The formation of large abscesses follows. The perforation of the bone and the escape of the pus into the soft parts is usually followed by a diminution of the pain. If the patient does not succumb to septicæmia or pyæmia, the subsequent course of these cases is, that death of the whole or a portion of the shaft of the bone takes place. After weeks or months the dead part, or sequestrum, as it is called, is separated from the living bone and remains embedded in the more or less massive layer of new bone which has been formed around it. There are usually one or more sinuses in the skin which discharge pus and lead through the soft parts and through the new bone to the sequestrum.

Very early evacuation of the pus contained within the bone through an opening made with a chisel, and thorough disinfection of the cavity before the inflammation has had time to spread widely within the bone and to invade the soft parts, is often the means of saving life, and usually

prevents the widespread destruction of bone which may otherwise take place. Hence the importance of recognising the disease as soon as possible.

Treatment.

If seen for the first time at a later period, wide incisions in the soft parts are necessary to allow of the escape of the pus, and free openings into and disinfection of the diseased cavity within the bone. If death of a portion of the shaft of the bone has already taken place, it is customary to provide for adequate drainage and to await the separation of the sequestrum before removing it by operation. In the most severe cases amputation may be necessary to save life. Where many bones are diseased, or the patient is exhausted by pyæmia or septicæmia, this treatment may be impracticable or ineffectual. Suppuration of a joint is treated by incision into and disinfection of the joint and the insertion into the joint cavity of one or more rubber drainage-tubes. The general treatment consists in the administration of abundant nutritious food and stimulants, with opium to relieve pain.

RICKETS.

Rickets is a condition of malnutrition characterised by a diminished amount of lime salts in, and an abnormal softness of, the bones, as the result of which characteristic deformities are produced. The disease occurs in infants and young children, usually during the first two years of life, occasionally later. Improper feeding and bad hygienic surroundings are the chief causes of the disease. Rickets of a severe type is rarely seen in America except among Italians and negroes.

Symptoms.

Restlessness at night, profuse perspiration, constipation, and an increased quantity of urine are among the early symptoms. The children are usually pot-bellied and the forehead is often bulging. The appearance of the teeth is delayed. The bones are soft, and the ends of the long bones, especially the anterior ends of the ribs and the lower end of the radius, are enlarged. Bowlegs and knock-knee, due to curvatures of the femur and tibia, are present in many cases. The diameter of the chest is increased from before backward and diminished from side to side, producing the deformity known as pigeon breast. Deformities of the bones of the pelvis are not uncommon. The disease is usually recovered from, but the deformities of the bones are in some cases permanent.

Treatment.

Proper and abundant food, and life out-of-doors under good hygienic surroundings, are the essentials of the treatment. Tonic drugs, among others cod-liver oil, syrup of the iodide of iron, and the lactophosphate of lime, are given with advantage. The deformities of the bones sometimes need to be corrected by operation.

For *Syphilitic Inflammation of Bone*, see *Venereal Diseases*, treated of in a subsequent chapter of this article.

CHAPTER V.

INJURIES AND DISEASES OF JOINTS.

INJURIES OF JOINTS. CONTUSIONS.

Contusions of joints are produced by mechanical violence applied through the medium of blunt objects. As in the case of fractures, the violence may be direct or indirect. The injury produced consists of a more or less extensive crushing of the soft parts around the joint, of the lining membrane of the joint, and of the ends of the bones. Severe contusions of joints are often complicated by fractures.

Cause.

When no fracture exists, the symptoms consist of swelling from distention of the joint cavity and the surrounding soft parts with effused blood, of slight or moderate pain felt chiefly when the joint is moved, more or less marked disability, and later of black-and-blue marks in the skin. The individual usually holds the joint slightly bent. Each joint has its own position in which distention of its cavity is attended by the least discomfort.

Symptoms.

Early and vigorous massage is the best means of causing the absorption of the effused blood. It should be used for fifteen or twenty minutes twice daily. Pressure with a rubber elastic bandage and active motion of the joint also hasten the cure.

Treatment.

SPRAINS.

When the ligaments which hold the bones in place are unduly stretched or torn we speak of the injury as a sprain. The lining membrane of the joint is often torn and crushed at the same time. The muscles and tendons passing over the joint may also be stretched or ruptured in severe cases. The force which produces a sprain may act in such a way that the normal range of motion of the joint in a certain direction is exceeded, or the joint may be moved in a direction in which normally little or no motion takes place. For example, the joints between the small bones of the fingers can be normally moved so that the finger is bent or straightened, or, surgically speaking, flexed or extended. If the finger is extended too far the ligaments which bind the bones together are torn and a sprain is produced. On the other hand, very little motion from side to side takes place between the bones of the fingers, and comparatively slight movements of this kind result in a sprain. The force which produces a sprain is exerted in such a way that, did it continue to act, the surfaces of bone which enter into

Cause.

the joint would no longer remain in contact—in other words, a dislocation would be produced.

Symptoms and Prognosis.

Sudden, violent pain is felt at the time of the accident. In severe sprains the disability may be complete from the first. In less severe cases the disability may be slight for some hours. Within a few hours the injured part becomes swollen and painful from effusion of blood into and around the joint. Attempts to use the limb are now attended by severe pain. After a day or two black-and-blue marks appear in the skin around the joint. The results of sprains, when properly treated, are usually favourable. Severe sprains, however, are sometimes followed by chronic inflammation of the joint of a serious character. The joint may become permanently stiff or remain unnaturally movable and weak. The time required for recovery from a sprain varies, according to the severity of the injury, from a week to many months. The joints most often sprained are the ankle and the wrist, less often the knee.

Treatment.

The opinions of surgeons as to the treatment of sprains are to some extent divided. There are those who depend almost entirely upon massage and upon active and passive motion of the joint from the first. Others believe that prolonged immobilisation of the joint is of great consequence. The writer believes that the following plan of treatment represents fairly the method pursued by the majority of surgeons in New York city: Sprain of the ankle, being the commonest form of the injury, may serve as an example. As soon as possible after the accident the foot and ankle should be immersed in a pail of water as hot as can be borne. The water should be kept at the highest possible temperature by adding more hot water from time to time. The immersion should be continued for an hour and a half or two hours. The foot and ankle should then be encased in a plaster-of-Paris splint well padded with cotton batting. If this cannot be done, the next best thing is to pad the foot and ankle with cotton batting and to apply over this a firm bandage, so as to exercise considerable pressure on the limb. The foot should be kept elevated for the first forty-eight hours, and after that the patient may go about on crutches. After acute inflammatory swelling has subsided somewhat, at the end of five days or a week, the bandage should be removed and the joint massaged vigorously twice a day. In addition to the massage, prolonged daily douching with hot and then with cold water is of benefit. During massage, passive movements of the joint should be made. After the douching and massage the plaster splint or bandage should be replaced and worn throughout the day. Plaster splints are removed by cutting through the plaster with a knife along the median line of the limb. If this is done carefully and the layer of plaster is not too thick, the splint can be opened by pulling on

the two cut edges so that the limb can be lifted out of it. The padding within the plaster casing can then be renewed and the splint replaced on the limb, if desired, and surrounded by a bandage to hold it in position. Under this treatment sprains of the ankle are usually recovered from in a fortnight, unless the injury is very severe.

DISLOCATIONS.

When the surfaces of bone which normally form part of a joint are displaced permanently from one another, the joint is said to be dislocated.

Cause.

Dislocations are ordinarily produced by mechanical violence, which may be direct (as is the case with fracture), indirect, or muscular. A dislocation may be associated with other injuries, such as fractures, wounds of the skin, the muscles, the blood-vessels, or the nerves. Usually dislocations are produced by violence acting upon a healthy joint. They may also occur as the result of disease, when they are called *spontaneous*. Occasionally they are congenital—*i. e.*, the individual is born with one or more joints dislocated. By far the most common dislocation is that of the shoulder joint. Next in frequency is the elbow, and then the hip and the fingers.

Mechanism.

The mechanism of dislocations resembles that of sprains, except that the violence is greater; the ligaments of the joint are not merely torn, but the ends of the bones are also forced out of place. The most common way in which this occurs is that the shaft of one of the bones acts as a lever. Motion of a portion of the bone near a joint is arrested at a certain point by a strong, tense ligament, a neighbouring bony prominence, or by the edge of the articular surface of the other bone forming a fulcrum. The shaft of the bone continues to move, and its articular extremity is literally pried away from its position in the joint. The extent to which the ligaments of the joint are torn varies much in different cases; usually the head of the dislocated bone tears a rent in the ligaments which surround it and projects through the rent into the neighbouring soft parts. On account of the relative strength or weakness of particular ligaments the dislocation usually takes place in certain definite directions, which are always the same when the position of the limb and the direction of the force are identical. The dislocated bone does not commonly move very far from the joint cavity, because it is restrained by the ligaments which remain untorn, and a knowledge of the relations of these untorn portions to the end of the bone is of the greatest consequence in determining what movements of the limb must be made in order to restore the bones to their natural relations.

The repair of dislocations after reduction has been made usually proceeds rapidly and without severe inflammatory symptoms. The rent

through which the dislocation took place heals. The effused blood is absorbed, and the stiffness of the joint which was present at first disappears. If, however, the injury to the soft parts is severe, including laceration of important blood-vessels or nerves, if the dislocation is compound, if the efforts at reduction have been prolonged and forcible, if the health of the individual is impaired, or if the joint is used too soon, various untoward results may follow.

Repair.

Rupture of important vessels may cause death from hæmorrhage, gangrene of the limb, or the formation of an aneurism. Infection will lead to suppuration and permanent stiffness of the joint or death from pyæmia or septicæmia. Rupture of large nerve trunks will produce paralysis of a part or the whole of the limb. Too early use may produce a recurrence of the dislocation, and inflammation and temporary or permanent stiffness of the joint; or in some cases a weak and flail-like joint results. Occasionally the dislocation may become habitual—*i. e.*, the displacement may recur from time to time as the result of slight degrees of violence. For a description of these conditions the reader is referred to works on dislocations.

Prognosis.

Deformity.—It is often easy to recognise certain dislocations at a glance by the attitude of the patient and the change in the appearance of the limb. Thus, in the commonest form of dislocation of the shoulder, where the head of the bone is displaced inward, the patient stands or sits with his body inclined toward the injured side. The elbow is separated from the body and the forearm is bent across the abdomen. The prominence of the fleshy part of the shoulder is diminished, and the outer part of the shoulder-blade seems, in poorly developed individuals (Fig. 33), to overhang the arm. The most important signs of dislocations are the presence of the end of the dislocated bone in a new situation outside the joint, and its absence from the normal situation. These two signs are sometimes very easy to establish. In other cases their recognition may be difficult or impossible. In joints which are not thickly covered by soft parts, like the knee, the position of the bones is easy to determine; in the hip, which is thickly covered with muscles, it may be impossible. Swell-

Symptoms.

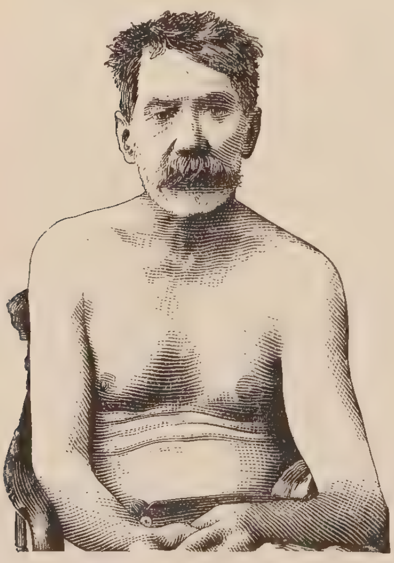


FIG. 33.—INWARD DISLOCATION OF THE SHOULDER. (Stimson.)

ing, which may take place rapidly after a dislocation, often obscures the relations of the parts and makes it impossible to feel the position of the bones. The dislocated limb may be really or apparently longer or shorter than the sound one.

Loss of Mobility.—Passive movements of the limb are usually restrained by the tense condition of those ligaments which remain untorn and sometimes by spasm of the muscles and the fear of pain. Movements can be made only in those directions which serve to relax the untorn portions of the ligaments, or which at least do not render them more tense. They vary in direction for each form of dislocation.

Pain.—Immediately following a dislocation pain of greater or less severity is felt. It may be due to the tension of the tissues about the joint or upon their laceration. In the former case it disappears at once when reduction is effected, in the latter it does not. Tingling or numbness of the limb is caused by laceration, stretching, or pressure upon the nerve trunks. If the nerves are torn the numbness may be permanent, and it is well to remember that the surgeon cannot be blamed for its continuance provided it existed before the dislocation was reduced.

Loss of Function.—In many cases the loss of function is complete, the limb is useless. Often, however, the patient continues to use the limb in a more or less limited way, and the dislocation may thus remain permanently unrecognised and unreduced.

Reduction.

Owing to the fact that *dislocations always require a surgeon for their safe reduction*, the writer believes that it would be fruitless to give instructions in a work of this character for the diagnosis and treatment of special dislocations. An accurate knowledge of anatomy is an absolute prerequisite for an intelligent understanding of the subject, and ill-directed attempts at reduction are fraught with such grave dangers to life and limb that they cannot be too severely condemned.

A few words as to the way in which reduction of dislocations is effected may, however, be of interest. From the history of the accident, and the position of the dislocated bones with reference to one another, the surgeon tries to discover in what direction the force acted to produce the dislocation, and in what portion of the ligaments the rent occurred through which the bone escaped. A knowledge of the position of the limb at the time of the accident is of assistance in determining these points. From his anatomical knowledge he should then know what ligaments and muscles must be relaxed and what bony prominences avoided in order to unlock the bone from its abnormal position, open the rent in the torn ligaments, and replace the bone in its normal position. In many instances these anatomical facts have been carefully studied out from dislocations artificially produced on

dead bodies and from dissections made in cases where persons died with dislocated joints. And certain definite manipulations have been found to be necessary in order to reduce particular forms of dislocation. Not very many years ago it was the custom to reduce many dislocations by pulling forcibly on the limb by means of powerful pulleys or by the combined efforts of several individuals. This treatment was often effective, but accidents of the most lamentable character occurred. Among them may be mentioned rupture of the large blood-vessels and nerves, and fractures. Sometimes the skin of the limb would give way and the part would be flayed in consequence, and occasionally it happened that the entire limb was pulled away from the trunk.

Modern Methods.

At the present time these methods have given place to gentler ones which depend for their success upon anatomical knowledge and skill, and do not require a great expenditure of force for their accomplishment. They consist of manipulations of the limb of various kinds, such as flexion and extension, rotation, abduction and adduction. These movements are combined with moderate traction or direct pulling upon the limb. In recent dislocations these measures are often successful at once. If they fail, the patient is given ether to relax the muscles and the manipulations are repeated—usually with success. After reduction is accomplished the limb is kept quiet with bandages for ten days or more, when active motion is gradually resumed. Swelling and inflammation are treated by wet dressings and the pressure of bandages. The sooner a dislocation is reduced the better. After a week reduction can usually be effected easily, but a delay of many weeks or months may render replacement impossible. The muscles become shortened, the end of the dislocated bone becomes firmly adherent to the surrounding parts, and the joint-cavity is gradually obliterated. Such a limb may, however, be quite movable and useful.

INFLAMMATION OF JOINTS.

Inflammations of the joints are called synovitis. They may be either acute or chronic. The acute inflammations may be divided, according to the character of the inflammatory product, into two principal varieties. In the first the cavity of the joint is distended with watery fluid which may contain shreds of fibrin. In the second the joint contains pus.

ACUTE SEROUS SYNOVITIS.

In the first variety, which is known as acute serous synovitis or arthritis, or, when a considerable amount of fibrin is present in the exudation, as acute sero-fibrinous synovitis, the lining membrane of the joint is swollen and the small blood-vessels of the membrane are dilated.

The symptoms are pain in the joint, increased by motion, tenderness, swelling, and distention of the joint-cavity with fluid, and sometimes increased heat and redness of the skin. The joint is held in a slightly bent position. Fever is absent or not high, except when the inflammation is the result of some disease which is regularly attended by fever. The disease is generally recovered from rapidly under suitable treatment, or it may become chronic, or pass under certain circumstances into the purulent form.

Symptoms and Outlook.

ACUTE PURULENT SYNOVITIS.

The second variety, in which the joint contains pus, is known as acute purulent synovitis or arthritis. In the mildest cases the lining membrane of the joint and the ligaments are swollen and congested, and the lining membrane is coated with fibrin and pus. In more severe cases all the joint structures undergo suppuration. The cartilages are softened and destroyed to a greater or less extent. The joint may be perforated with the production of abscesses in the surrounding tissues, and the bones may be involved in the inflammation. In the most severe cases a putrid inflammation takes place, with the formation of the gases of putrefaction.

The disease often begins with a chill, followed by high fever and marked prostration. The joint swells rapidly, and the swelling often extends over the entire limb. There is intense pain increased by movement, and usually complete inability to use the extremity. The skin over the joint is red and hot. The subsequent course of the disease depends upon the severity of the process and the promptness of the treatment. Under favourable circumstances recovery may take place with a movable joint. In other cases the joint is obliterated and remains permanently stiff; the ends of the bones unite by fibrous tissue or new bone. In more severe cases septicæmia or pyæmia cause death, or amputation of the limb may be the means of saving life.

Symptoms and Outlook.

The causes of acute inflammation of the joints are very various. The serous or sero-fibrinous form may be due to injuries, such as contusions, sprains, dislocations, and fractures in the neighbourhood of the joints. Exposure to cold and wet is sometimes assigned as a cause. The disease occurs in the course of many of the acute infectious diseases, such as typhoid fever, diphtheria, mumps, and measles; also in gonorrhœa and syphilis, and, finally, in acute rheumatism of the joints.

Causes.

The purulent variety is always attended by the presence of bacteria in the fluid contained in the joint. The disease may be due to direct infection through a wound in the skin which opens the joint, or from a local

inflammatory process in the bones or soft parts from which direct infection of the joint takes place. Often the process is secondary to some other disease, such as pyæmia, dysentery, small-pox, measles, scarlet fever, diphtheria. In these cases infection takes place through the blood, and one or several joints may be involved. In pyæmia the purulent effusion into the joints may appear very suddenly and without any of the symptoms of acute inflammation. Acute rheumatism is probably also an acute infectious disease caused by bacteria, with localisation of the microbes in the joints and in the lining of the heart. For a description of acute rheumatism of the joints and gout the reader is referred to the article in this work on *Diseases in General*.

Treatment.

The treatment of acute serous synovitis consists, in the early stages, of immobilisation of the limb on a splint in an elevated position, in the application of cold to the joint by means of an ice-bag, or of cold wet dressings. When the pain and effusion have subsided somewhat, it is customary to use massage and pressure to hasten the absorption of the fluid. Pressure may be applied by means of a rubber bandage in which the limb is enveloped. Once or twice daily the bandage is removed and the limb is douched and massaged. The patient is also allowed to use the limb moderately. Under this form of treatment recovery is usually rapid, the joint returning to its normal condition in from one to several weeks. If the effusion does not disappear and becomes chronic, the fluid is sometimes withdrawn from the joint through a hollow needle under the strictest antiseptic precautions, after which pressure is reapplied. The operation may need to be repeated.

The treatment of acute suppurative inflammation of the joints depends upon the severity of the infection. In the mildest cases, where the effusion consists of serum and fibrin, with only a small amount of pus, the so-called "catarrhal synovitis," evacuation of the fluid through a needle or through one or several small incisions into the joint, and the subsequent washing out of the joint-cavity with a solution of carbolic acid or a solution of corrosive sublimate (1 to 1,000), followed by an antiseptic dressing and complete rest of the joint for several weeks, may suffice. In the more severe cases, where constitutional symptoms are present and the effused fluid is distinctly purulent in character, the joint must be freely opened, washed out with an antiseptic solution, and drained at dependent points through rubber tubes inserted into the joint-cavity. Abscesses in the soft parts must be freely opened and the limb dressed, immobilised, and elevated. Should the fever persist and the discharge of pus continue in spite of thorough drainage and disinfection of the joint, it may be necessary to remove the ends of the bones which form the joint, or in the severest cases to amputate the limb. When many joints

are involved, as is sometimes the case in pyæmia, the condition is almost hopeless.

In favourable cases, where the joint-cavity is not destroyed and some motion remains, massage and passive motion are used to increase the mobility after the inflammatory process has entirely subsided. But in all cases where a stiff joint is to be feared the limb should be placed and kept in the position in which it will be most useful—the knee joint very slightly bent, the elbow bent to nearly a right angle, the foot at right angles to the leg. The constitutional treatment is supporting and stimulating.

CHRONIC INFLAMMATIONS OF THE JOINTS.

Tuberculosis of the joints has been spoken of elsewhere. For a description of the other chronic disturbances of the joints, the reader is referred to works on surgical pathology and to the article on *Diseases in General* in this book. Certain deformities involving the joints will be mentioned under *Surgery of Special Regions.*

WOUNDS OF JOINTS.

Non-penetrating Wounds.

Wounds of the soft parts overlying a joint but which do not penetrate the joint-cavity are of no greater importance than wounds elsewhere, except that if there is much loss of substance the resulting scar may, by contraction, interfere with the free movement of the limb. For instance, if a large piece of skin is lost from the bend of the elbow on the front of the limb, the contraction of the scar may render complete extension of the elbow joint impossible.

Such wounds should be dressed with the limb in a position which will prevent contraction as far as possible. In the condition named above the elbow should be kept straight, not bent. Such wounds are most rapidly healed, and the contraction best prevented by the application of skin grafts to the raw surface at once or after a week, when the healing process is well under way.

Penetrating Wounds.

Wounds which penetrate joints are very serious injuries, on account of the danger of acute suppurative inflammation of the joint which follows infection of the joint-cavity. The diagnosis of a penetrating wound of a joint is easy when the wound gapes so that the white glistening cartilages which cover the ends of the bones can be seen. When the interior of the joint is not visible, penetration can be inferred from the escape through the wound, soon after the injury, of a transparent sticky fluid (the synovial fluid), which serves to lubricate the joint surfaces. When in doubt as to whether a wound penetrates a joint or not, it is best to treat the wound as though the joint were opened.

The entire limb should be cleaned and disinfected, as described in the *Treatment of Wounds*, and the wound itself should be thoroughly douched with boiled water or corrosive-sublimate solution (1 to 1,000). It is unwise to probe the wound or to introduce a finger into the joint. Foreign bodies should be removed. A large antiseptic dressing should be applied and the limb immobilized on a splint. If infection has already occurred, the synovial fluid will be mixed with pus and the joint will be painful. The treatment is then the treatment of acute purulent inflammation of joints, as already given.

CHAPTER VI.

TUMOURS.

Definition.

The Latin word *tumor*, a swelling, has received in medical language a special meaning. A tumour may be defined as "an increase in volume through a growth of new tissue, which fulfils no useful purpose in the organism," and which often departs in some degree from the normal type of tissue in which it occurs. All the inflammatory swellings, whether acute or chronic, are excluded from what we call tumours.

Classification.

Tumours may be divided into a number of groups, according to the character of the tissue of which they are composed. Thus many tumours consist chiefly of tissue which is derived from and resembles more or less closely what is known as connective tissue—the kind of tissue which forms the framework of the entire body. To this group belong the tumours which are composed of fibrous tissue, of bone, cartilage, fatty tissue, of blood and lymph vessels, and lastly the tumours which have received the name of fleshy tumours or sarcomata. Another group includes those tumours which are made up of muscle tissue; a third, those made up of nerve tissue; a fourth, those made up largely of cells which resemble or are derived from the cells of the skin and mucous membrane and the cells which line the interior of glands like the breast and the salivary glands. To this group belong the different forms of cancer. Still another group of tumours are composed of various types of tissue quite irregularly distributed. Such tumours are called mixed tumours. In them are sometimes found bones, hair, teeth, portions of skin, brain substance, fat, and other tissues.

To account for the occurrence of tumours is not always easy. Certain circumstances seem to favour their growth. Thus cancer occurs more commonly in advanced life. The sarcomata sometimes follow an injury.

Cancers occur in situations where the tissues are exposed to prolonged mechanical or chemical irritation—on the lower lip and tongue of excessive smokers, for instance. An attractive theory, which explains the occurrence of many tumours, is that during the earliest development of the body minute portions of tissue have been displaced from the situations in which they belong. That later in life these displaced tissue cells may begin to grow and multiply, forming a tumour which in this case does not resemble the kind of tissue in which it originated. There remain, however, a large number of tumours for the occurrence of which no cause can be assigned.

Cause.

Tumours all have one characteristic in common. The new growth of tissue, once started, shows no tendency to limit itself, but keeps on growing indefinitely. The growth may be very slow; certain kinds of tumours may exist for many years without attaining a great size, while others spread with great rapidity.

The effects of tumours on the organism vary greatly in importance. There are many tumours which are inconvenient simply from their size and weight or from the deformity which they produce. But the same tumour which upon the shoulder or back might merely cause trifling inconvenience, would, were it growing within the cavity of the skull, be productive of the most serious consequences.

Effects.

Certain peculiarities in the mode of growth of tumours of different kinds are important. Many tumours are composed of cells which do not depart in any way, either in size, shape, or manner of arrangement, from the normal tissues of the body. They grow, as a rule, quite slowly, separating the tissues around them mechanically as they increase in size. The line of separation between the tumour and the surrounding tissues remains sharply marked. They are often surrounded by a distinct capsule of connective tissue, and can sometimes be shelled out of this inclosing envelope like an orange out of its rind. When removed by operation they show no tendency to return. They are classed among the innocent or benign tumours.

Benign Tumours.

Very different in their mode of growth from these are the so-called malignant tumours. Starting in tissue which may or may not resemble the tissue of which the tumour is composed, they are characterized by rapid growth. The cells of which the tumour is composed may resemble more or less closely the normal tissue cells, or the cells may be imperfectly developed like certain cells which are found in the embryo, or many of the cells may be of an unusual or bizarre form. The relation of the cells to the connective-tissue framework of the tumour is often peculiar, and sometimes characteristic. The growth of the tumour is accomplished at the expense of the surrounding tissues. The tumour cells multiply rapidly and penetrate

Malignant Tumours.

into the substance of the normal structures, displacing the healthy tissue cells and causing their destruction. This infiltration, as it is called, takes place in all directions, and invades any and every structure without regard to its character. Skin, fat, muscle, blood-vessels, nerves, bones, are invaded, and the healthy elements of the body are thus replaced by tumour tissue. The blood supply of the part is often greatly increased by this unusual call for nutriment, but often the enlargement of the blood-vessels does not keep pace with the rapid growth, so that while the tumour is advancing in one direction its older portions are degenerating and undergoing necrosis for want of nutriment. In this way death of the skin overlying the tumour may occur, and ulceration. Unless carefully protected from infection, putrefaction of the raw surface may result, or suppuration and a low grade of septicæmia.

The spread of the disease is, however, not confined to the immediate vicinity of the tumour. The lymphatic channels are invaded and tumour cells are carried by the lymph current to the neighbouring lymphatic glands, in which secondary tumours having all the characteristics of the original growth are formed. The cancers and the sarcomata comprise the greatest number of malignant new growths. The former spread to distant parts chiefly through the lymphatics, the latter chiefly through the veins. As the result of ulceration the walls of the blood-vessels may be destroyed, and serious or fatal bleeding may take place.

The formation of secondary tumours is not confined to the regions in the immediate neighbourhood of the primary growth. They may appear in distant parts and in large numbers.

Prognosis.

In all cases when malignant tumours are removed a strong tendency to return manifests itself, and the recurrence may take place at once, from portions of the tumour which are left behind, or later, after months or years, in the scar, in the nearest lymphatic glands, or in the internal organs. This tendency to recurrence varies greatly. Some of the cancers and sarcomata are comparatively benign, while other forms grow with great rapidity and involve distant regions at a very early period. The inevitable result of a malignant tumour which is not removed by operation is the destruction of the life of the individual. Death may occur after months or years, and may be the result of a variety of causes. The increase in size of the tumour may, by pressure, interfere seriously with the functions of vital organs. For instance, a tumour within the skull may interfere by pressure with vital portions of the brain and produce death. A tumour in the stomach, situated at either orifice of the organ, may, by narrowing the inlet or outlet, cause death by starvation. A tumour of the lung or kidney may completely destroy the functional activity of the organ by replacement of the normal tissues by tumour tissue. Very often death from a malignant tumour takes place

from a variety of causes operating at the same time. There may exist a large ulcerated suppurating area on the surface of the tumour through which the patient continually absorbs bacterial poison. Bleeding from the raw surface takes place and reduces the patient's strength. The pain and sleeplessness which are often present from pressure on the nerve trunks add a further depressing element. The secondary tumours which may exist elsewhere in the body produce their own destructive results. The patient thus steadily loses ground and becomes gradually weaker until death from exhaustion takes place.

A special description of the different varieties of new growth, with their localization, mode of growth, and physical characters, would require a separate volume, and could hardly prove of much practical value in a work intended for popular reading; but certain facts in regard to the treatment of tumours may be of interest. A very important fact of a practical nature may first be stated—namely, that *a lump or enlargement appearing anywhere in or upon the surface of the body is to be regarded with suspicion*, and should always be submitted to a surgeon for examination at the earliest possible moment, and for this reason: While many tumours begin as innocent or benign growths and so remain, a certain proportion may and do after a time change in character and become malignant. Further, the dangers from the removal of a small tumour may amount to nothing, whereas at a later period the mere operation may be difficult and dangerous. The chances of complete removal and cure of a malignant tumour are comparatively good during an early stage of its development. In a certain proportion of cases the tumour does not return, and this proportion is far greater when the operation is done early, when the tumour is small. When the growth has formed attachments to the surrounding parts and has extensively invaded the lymphatic glands, or when secondary tumours have been formed through the entrance of tumour tissue into the circulating blood, cure is not to be expected.

Treatment.

The quickest, least painful, least dangerous, and surest means of eradicating a new growth is, as a rule to which there are few exceptions, to cut it out with a knife. Other means, such as caustics, appear less dreadful to the patient, but they are for the most part tedious, painful, and uncertain in their results. To no condition do these remarks apply with more force than to the new growths which so commonly occur in the female breast. As a rule, they should be removed as soon as a surgeon can say that a tumour is present. If done at a very early period the resulting deformity will be slight, except in cases where the tumour is evidently of a malignant character. In cases where it is evident at the time of the operation that a cancerous tumour of the breast exists, the entire breast, the large muscle on the front of the chest, and the contents of the armpit as

high up as the collar bone should be removed in every case. This extensive operation, which certainly sounds very formidable, is not attended by great danger, the movements of the arm are preserved to a surprising degree, and the percentage of actual cures is very much greater than under any other form of treatment.

Even if the operation does not result in cure, the removal of malignant new growths, when the condition admits of the eradication of all the evidently diseased tissues, is of advantage. The patient is relieved at once from the presence of the tumour upon which his or her mind is centred to the exclusion of everything else. The wound usually heals completely within a fortnight. The symptoms produced by the mechanical pressure of the tumour, such as neuralgic pains, are stopped at once. The mental condition of the patient is usually hopeful until the recurrence takes place. Life is usually considerably prolonged, and the patient enjoys a period of comfort. The recurrence may not take place for several years. The recurrent growth is sometimes of a less malignant character than the original tumour and its removal may result in cure. The recurrence may take place in internal organs, and death may thereby be rendered comparatively painless and free from the antecedent suffering which an extensive malignant growth on the surface of the body usually entails.

CHAPTER VII.

SURGICAL INJURIES AND SURGICAL DISEASES OF SPECIAL REGIONS.—INJURIES AND DISEASES OF THE HEAD AND FACE.

INJURIES OF THE SCALP.—CONTUSIONS.

Symptoms.

The skin of the scalp is closely adherent to a dense layer of tissue beneath it. When laceration of blood-vessels occurs just beneath the skin the close connection between it and the deeper layer prevents the effused blood from spreading far, and a sharply marked, tense swelling is formed at the seat of the injury, producing bumps, as they are called, familiar to every one. Between the dense deeper layer of tissue and the periosteum of the skull, on the contrary, the connections are loose, and hæmorrhage in this situation frequently spreads over a wide area. These injuries, when not complicated by an open wound or an injury to the skull or its contents, are not serious. The bleeding beneath the skin usually ceases speedily, or it can be stopped readily by cold and pressure, and the effused blood is usually absorbed.

One practical point in connection with the deeper extravasations may

be mentioned. After some hours or days the outer border of the clot may be felt as a hard rim, over which the examining finger slips and seems to pass, on pressure, more deeply towards the centre of the swelling, giving rise to the impression that the skull is actually depressed at this point. The hard rim of the clot is mistaken for the skull itself. By rubbing and pressing for a moment the hard rim can be made to disappear, and no apparent depression of the skull remains.

When bleeding takes place between the skull and its periosteum, new bone is sometimes produced, which leads to temporary or permanent thickening of the skull at this point. This condition may be followed by nervous symptoms, occasionally by epilepsy.

Treatment.

If the swelling increases in size rapidly, an ice bag or a firm pad and bandage may be used to stop it. After twenty-four hours the application of cold may be stopped, and a firm pad and bandage may be worn until the swelling has disappeared. Massage over the effused blood clot, practised twice daily for ten or fifteen minutes, hastens absorption. The smallest wound of the skin should be treated antiseptically.

Wounds of the scalp bleed profusely. The hæmorrhage may be stopped temporarily by finger pressure, and permanently by a tampon or a pad of antiseptic gauze. The scalp should always be shaved for an inch or two around the wound, and the most careful antiseptic precautions should be observed. When large portions of the scalp are stripped away, as sometimes happens in machinery and other accidents, the wound should be carefully cleaned and the torn portions replaced. Wounds of the scalp heal very rapidly unless infected.

INFECTED WOUNDS OF THE SCALP.

Symptoms.

An infected wound of the scalp should always be regarded as a very serious condition. Infection may be recognised by pain and a swollen, boggy condition of the skin around the wound. There may be a discharge of pus from the wound or none. The danger arises from burrowing of pus beneath the scalp, which takes place insidiously and rapidly, and from the possible spread of the infection to the brain and its membranes through veins in the scalp which communicate with the interior of the skull, or through the skull itself.

Treatment.

An infected wound of the scalp needs prompt and energetic treatment. The limits of the inflamed cavity should be freely exposed from one end to the other by a cut made as nearly as possible from before backward, for in this direction fewer blood-vessels will be divided. The wound should be thoroughly disinfected with sublimate solution (1 to 1,000), lightly packed with iodoform gauze or with sublimated gauze over which a mass of gauze wet with three-per-

cent. ichthyol solution, or with the solution of sugar of lead and alum, should be placed and held in position with a bandage. The dressing should be changed daily until it is certain that the inflammation is not advancing.

FRACTURES OF THE SKULL.

Of the Vertex and Base; Causes.

Fractures of the skull are serious, not so much on account of the injury to the bones themselves, but because the contents of the skull, the brain and its membranes, are apt to be directly or indirectly involved. The fracture may take place in the convex, dome-like portion of the skull which lies above and behind the eyes and the ears, when it is known as a *fracture of the vertex*, or the floor of the skull which supports the lower surface of the brain may be the seat of fracture, in which case it is spoken of as a *fracture of the base.* Fractures of the vertex of the skull are commonly the result of direct violence, blows or falls upon the head being common causes. Fractures of the base of the skull are more often the result of indirect violence. For example, a fall upon the buttocks may cause a fracture of the base of the skull, the force being transmitted through the spinal column, or a fall upon the vertex may produce a similar fracture. Fractures of the vertex, when due to direct violence, may be attended by depression of the fragments so that pieces of bone are driven into or pressed upon the brain. The inner surface of the skull is harder and more brittle than the outer surface, and the splintering of the inner table, as it is called, may be more extensive than the injury to the outer table would indicate. There may or may not be a wound in the skin communicating with the fracture.

Symptoms.

The signs and symptoms of fracture of the skull are partly those of injury to the bones and partly those produced by the injury to the brain and its membranes. A simple fissure of the skull without any wound of the skin gives no distinctive symptoms. Depression can often be felt through the scalp as a distinct concavity on the surface of the skull, or an edge of bone can sometimes be felt bordering the depression. In the case of compound fractures of the vertex the injury may be quite apparent to the eye or finger, or when the brain is torn, brain substance may escape through the wound. Fractures of the base of the skull are often attended by the effusion of blood into the eyelids and conjunctivæ when the fracture is situated in the anterior part of the skull, or by the escape of blood and watery fluid (the cerebrospinal fluid) from the external ear, when the fracture is situated farther back. The symptoms of injury to the brain and its membranes may be divided into three categories: *concussion, compression, and laceration of the brain.* These conditions, however, often coexist, and it may be im-

possible to determine at once which of the three is producing certain of the symptoms from which the patient suffers.

Concussion of the Brain; Cause and Symptoms.

Concussion of the brain is produced by mechanical violence such that the brain suffers a severe shock without undergoing any changes in its substance appreciable to the naked eye. The symptoms of concussion of the brain appear at once after the accident. They are complete or partial unconsciousness, momentary or prolonged, followed by headache, vomiting, and giddiness. The temperature of the body may be increased or diminished. The pulse is usually weak and slow. The breathing is often superficial at first, but in some cases deep and snoring. The sensibility of the skin is diminished. The pupils of the eyes may be dilated or contracted. They contract on exposure to a bright light. The period of unconsciousness or stupor may last only a few seconds or be prolonged for days. A period of excitement follows, during which the patient is irritable and complains of headache. The face is flushed and the pulse rapid and forcible. The shorter the period of unconsciousness the better the chances of recovery. Concussion of the brain is sometimes followed by a condition of nervous prostration resembling nervous prostration from other causes.

Treatment.

The early treatment is that of shock, except that alcohol is not administered. During the stage of excitement an ice bag on the head and the administration of bromides, phenacetine, and other quieting drugs are useful. In every case of concussion of the brain fracture of the skull should be looked for.

Compression of the Brain; Cause, Symptoms, and Prognosis.

Compression of the brain may be caused by a depressed fracture of the skull; by the presence of a foreign body in the cranial cavity—a bullet, for example; by the presence of extravasated blood within the skull, caused by the rupture of blood-vessels resulting from external violence or disease; and by the rapid accumulation of pus or other fluid within the skull, due to infection with pus microbes through a wound or through the blood. The condition is often complicated by the symptoms of concussion and laceration of the brain, and sometimes acute alcoholism, disease of the kidneys, apoplexy, and opium poisoning must be excluded before a diagnosis can be reached. When due to a depressed fracture of the skull or to the entrance of a foreign body into the brain the symptoms usually appear at once. When due to the rupture of a blood-vessel the symptoms may come on slowly, after several hours, when the mass of effused blood has attained a considerable size. Under these circumstances the symptoms of compression will be preceded by headache and a feeling of fulness in the head. The face is flushed. The pulse is rapid. As the pressure within the skull increases, nausea and vomiting

may occur. The individual gradually falls into a condition of stupor, and finally of complete unconsciousness. There may now develop paralysis of motion on one or both sides of the body, complete or partial. If one side of the brain is affected, the paralysis will be on the opposite side of the body from the injury to the brain. The pupils of the eyes are often contracted or dilated, or of unequal size. They do not contract when exposed to light. There may be squinting. The pulse becomes slow and full, the breathing deep and snoring. There is often a rise of temperature. From this condition of coma the patient can not be aroused by any amount of shouting or shaking. The coma may be gradually recovered from as the brain accustoms itself to the increased pressure, or death may occur after hours or days from paralysis of respiration, or later from inflammation of the brain or its membranes.

Laceration of the Brain; Cause, Symptoms, and Prognosis.

Laceration of the brain as the result of mechanical violence may be attended by no symptoms unless special parts of the brain are injured, in which case there may be a great variety of paralyses, depending upon the portions of the brain which are injured, such as loss of speech, blindness, inability to control the action of the muscles, so that combined movements which serve some definite and useful purpose—such as walking—are no longer possible (ataxia, or loss of the power of muscular co-ordination), paralysis of respiration and death, paralysis of one or more limbs or of the face. Fractures of the skull and wounds of the brain and its membranes are especially liable to infection with pus microbes. When such infection takes place the inflammatory product is apt to cause such serious disturbances within the skull that death, preceded by headache, delirium, convulsions, and coma, is a frequent consequence.

Treatment.

The treatment of compression of the brain from depressed bone or a blood-clot on the surface of the brain is to elevate the depressed bone and remove loose splinters with suitable instruments. To remove blood-clots and stop any bleeding which may still be going on within the skull, a hole is made through the skull with a chisel and mallet, or with a boring instrument, and the blood-clots are scooped out and the bleeding point tied if necessary. When no external wound or fracture of the skull exists, the location of the clot must be determined by the symptoms. This can be done only when the paralysis is such that a definite region of the brain is known to be involved. The treatment of inflammatory complications is to let out the pus when that is possible.

The diagnosis of opium poisoning can generally be made from the appearance of the pupils of the eyes, which are contracted to pin-point size, and from the very slow breathing. There is no paralysis, and the patient can often be aroused momentarily. In coma from disease of the

kidneys the legs are often swollen, and the skin of the face may have a waxy look. In apoplexy there is complete unconsciousness, paralysis of one or both sides of the body, and snoring breathing. The signs of fracture of the skull are absent. In acute alcoholic intoxication the patient smells of alcohol. There is no paralysis. The pupils of the eyes are often contracted. A smart blow on the cheek will usually arouse the patient momentarily, when the pupils of the eyes will dilate. In case of doubt the patient should be treated as though he had a fracture of the skull or some serious disease, and he should be sent to a hospital, not to a police station-house.

Differential Diagnosis of Coma.

THE FACE.

Owing to the extremely rich blood supply of the face, injuries of this region heal with great rapidity. A clean-cut wound of the face, the edges of which are properly brought together, is usually completely healed in a week, so that the scar is scarcely visible except on close inspection. Wounds of the face bleed very freely, and dangerous hæmorrhage may take place if one of the larger arteries is cut. The best temporary measure to stop the bleeding is finger pressure applied to the bleeding point. In some cases of wounds of the cheeks and lips the whole thickness of the part may be compressed between the fingers and thumb, a finger or two being introduced into the mouth. Arterial bleeding from one of the larger arteries of the face usually requires a ligature or deep stitches to stop it permanently, although a tampon may be successful in some situations. Careful stitching of wounds of the face is necessary to avoid scarring, therefore a surgeon should be seen if possible. This is particularly true of wounds of the eyelids, nose, and lips. Infected wounds of the face require, as elsewhere, thorough disinfection and a free opening for the escape of pus. Contusions of the eyelids are a common accident and lead to the condition known as a black eye. The eyeball itself is seldom injured by blunt force, owing to the protection which is afforded by the bony margin of the orbit. During the first few hours after the receipt of the injury cold applications may be made to the part. Later, gentle massage will remove the discoloration in a few days. A poultice applied over the eye leads to great swelling and disfigurement, and should never be applied.

Wounds of the Face.

Contusions.

Boils and carbuncles of the face should be opened early and dressed with a wet antiseptic dressing. A special form of carbuncle occurs on the face, which is attended by a rapid spread of the inflammation through the veins to the interior of the skull, and death from inflammation of the membranes of the brain. Early incision and disinfection offer the only hope of sav-

Boils, Carbuncles, and Anthrax.

ing life. Anthrax, or malignant pustule of the face, occurs among persons who handle hides and wool. Occasionally anthrax results from the bites of flies which have fed upon the body of an animal dead of anthrax. The diseased hides carry the anthrax bacillus, which, when brought by dirty fingers in contact with a minute wound on the face, causes, in three or four days, the formation of a painful inflamed spot. The centre of the spot is occupied by a blister containing bloody fluid. In a few hours the blister dries to a black crust. Around this centre the swelling and redness spread rapidly, and after a variable period, usually after a few days, the bacilli enter the blood current and multiply everywhere in the body, and the individual dies in eight or ten days from the beginning of the disease, from high fever, prostration, delirium, diarrhœa, and collapse. The best treatment is to cut out the pustule at an early period and disinfect the wound with corrosive-sublimate solution (1 to 500), or with a solution of chloride of zinc (forty grains to the ounce of water). If done before constitutional infection has taken place recovery is the rule.

Erysipelas and lupus of the face have been spoken of elsewhere.

Cancer.

A great variety of tumours occur upon the face. The most important is cancer. Prolonged local irritation seems to have some effect in its production—for example, cancer of the lip in smokers. The disease is much more common in men than in women, and rarely occurs before the fortieth year of life. Scars, warts, horns, wens, and other innocent growths upon the face often form the starting point of cancer. If an ulcer forms upon the surface of such a growth, which scabs over but does not heal, if the base of the ulcer becomes hard and the hardness spreads in width and depth, or if a cauliflower-like growth springs up from the base or edges of the ulcer, the diagnosis of cancer is almost certain, and the sooner it is removed by operation the better the prospect of cure.

Harelip.

Harelip is a deformity of the upper lip, due to a failure of union between the parts in the embryo. The cleft is situated on one or both sides of the median line. It is sometimes combined with cleft palate. Babies with harelip can sometimes nurse at the breast. If cleft palate exists at the same time they can not, and must be fed from a bottle with a large, long rubber teat. The time ordinarily chosen to operate for the relief of the deformity is between the fifth week and the sixth month of life. Earlier operations are attended by a higher mortality.

THE NOSE.

For fractures of the nose, see *Fractures.*

Foreign bodies usually gain access to the nasal cavities from the front. They are sometimes intentionally introduced by children and insane per-

sons. Among such foreign bodies may be mentioned peas, beans, pins, pebbles, beads, and shoe buttons. Occasionally vomited matters gain access to the nose from behind. Intestinal round worms have occasionally reached the nose in this way. The symptoms produced are pain, and, if the foreign body is not removed, inflammation and sometimes disease of the bones. The foreign body may form the nucleus of a stone composed of the salts of lime.

Foreign Bodies.

The foreign body, when visible, may be seized with a forceps and removed. A bent loop of wire may be passed beyond it and withdrawn, carrying the foreign body in front of it. If a surgeon can be reached it is better not to interfere, lest unskilled efforts force the foreign body still further into the nose.

Treatment.

Bleeding from the nose may occur as the result of wounds or in the course of diseases, such as tumours within the nose, erysipelas, typhoid fever, etc. Among "bleeders" serious nose-bleed is not uncommon. The blood usually comes from the front part of the nasal cavity.

Hæmorrhage.

In slight cases a recumbent position, face downward, and firm closure of the nostrils with the fingers for a few minutes, will usually suffice. The patient should avoid blowing the nose for some time after the bleeding has ceased. If this simple measure does not suffice, snuffing up of ice water or of water containing a little alum may be tried. In severer cases it may be necessary to plug the nose from in front through the nostrils, or to plug the outlet of the nose into the throat behind as well. This latter method is always effective, but it is difficult to accomplish, and should only be attempted by a surgeon.

Treatment.

THE EYE.

A foreign body, such as a cinder or a minute bit of iron, can easily be wiped away from the fold of the lower lid with the end of a match covered with a little cotton. When the foreign body lies beneath the upper lid its removal may be a little more difficult. The patient sits facing a bright light and rests his head against the operator's chest, who stands behind him. The operator places the tip of the forefinger of his left hand against the upper eyelid, and with the forefinger and thumb of his right hand he grasps the edge of the upper lid lightly but firmly, pulls it downward, then turns it upward and backward over the tip of the left forefinger, thus turning the lid inside out. If properly done, the lid will remain in this position. The foreign body may then be sought for and wiped away with a match covered with cotton. When bits of iron or other bodies are embedded in the transparent front of the eye or cornea they must be removed with a needle. The operation is a delicate one, and should not be attempted

Foreign Bodies in the Eye.

except where a surgeon can not be reached. Cocaine solution—four per cent.—dropped in the eye renders the operation painless.

Wounds of the Eyeball, and Inflammation.

Wounds of the eyeball and wounds complicated by the presence of a foreign body embedded in the ball of the eye are serious injuries, and always require the care of an eye specialist. If improperly treated, the sight of both eyes may be lost.

Inflammations of the eyes should never be treated at home, but always by a competent eye surgeon.

THE EAR.

Foreign Bodies in the External Auditory Canal.

In addition to such foreign bodies as gain access to the nose, insects occasionally find their way into the external ear. Flies may lay their eggs in the canal, and these hatch out into maggots. The extraction of foreign bodies from the ear demands great care lest the delicate membrane of the drumhead be injured. Large masses of wax sometimes collect in the ear and give rise to ringing sounds and deafness. These, as well as foreign bodies, can often be removed by washing out the canal with warm water and salt. A large syringe should be used for the purpose, and the ear should be pulled upward and backward and the stream of water directed a little upward or downward, not directly into the canal. The syringing should be done gently, and several pints of water may have to be injected before the wax or foreign body comes away. The instrumental removal of foreign bodies from the ear must be left to a surgeon. Maggots and live insects are best removed by pouring warmed olive oil into the ear. The dead insects may then be washed out with warm water and a syringe.

Boils in the External Auditory Canal.

Boils often occur in the external auditory canal. The affection is very painful. Sometimes the recognition of the boil is obscured by swelling. The treatment is early incision. After the boil is opened the pain usually ceases. The canal may then be cleaned by very gentle syringing with a warm solution of boric acid in water (1 to 50).

Rupture of the Drumhead.

Rupture of the drumhead of the ear may be the result of direct violence from the entrance of foreign bodies into the canal, of indirect violence from blows upon the head, or of falls. A most frequent cause is a blow or a so-called box upon the ear. The symptoms of rupture of the drumhead from external violence are pain, partial deafness, and sometimes the symptoms of concussion of the brain. The treatment is to keep the patient quiet and to plug the canal lightly with antiseptic cotton. Injections should not be used. The rupture usually heals readily if uncomplicated.

Acute catarrhal inflammation of the middle ear, of the air chamber which lies behind the drumhead, is a frequent disease among children.

Acute Catarrhal Inflammation of the Middle Ear.

It occurs as a complication of catarrhal inflammations of the throat and nose and in the course of the eruptive fevers and typhoid. The symptoms are pain in the ear, deafness, giddiness, and buzzing in the ear. Sometimes there is high fever, with delirium and tenderness over the mastoid process of the temporal bone, the prominent bony point behind the ear. The treatment consists of puncture of the drumhead in severe cases to let out the retained secretion, and of inflation of the middle ear through the Eustachian tube. The disease often becomes chronic, and is a frequent cause of deafness.

Acute suppurative inflammation of the middle ear is the result of infection with pus microbes through wounds, or in the course of febrile

Acute Suppurative Inflammation of the Middle Ear.

diseases. The symptoms are those of catarrhal inflammation, but much more severe. Death may occur in some cases from a spread of the inflammation to the membranes of the brain. The treatment consists of puncture of the drumhead and antiseptic irrigations of the ear. The disease often becomes chronic, and is then a constant menace to the life of the individual from the danger of the spread of the inflammation to the membranes of the brain.

THE TONGUE, MOUTH, AND THROAT.

Wounds of the tongue occur from catching the organ between the teeth during epileptic attacks, and from falls or blows beneath the chin;

Wounds of the Tongue.

also from sharp foreign bodies contained in the food, and from gunshot wounds. Other accidental wounds of the tongue are rare. Wounds of the tongue heal readily. They should be sewed up when not very small. The bleeding usually ceases as soon as the stitches are put in. The patient should use a mouth wash of listerine, boric acid (1 to 50), or permanganate of potassium (1 to 1,000).

Bees and wasps may be introduced into the mouth on fruit, and sting the tongue, causing pain and considerable swelling. A weak solution of

Acute Inflammation and Tubercular Ulceration.

ammonia water used as a mouth wash is the best treatment. If the swelling of the tongue is extreme, scarification of the surface of the tongue with a sharp knife will relieve it.

Acute inflammation of the tongue occurs as the result of infected wounds of the organ, from extension of an acute inflammation in the neighbourhood, and in the course of acute febrile diseases. The tongue swells rapidly, and may reach double its normal size. Treat-

ment by antiseptic mouth washes is usually successful. If an abscess forms it must be opened early.

Tubercular ulceration of the tongue occurs in persons who have consumption of the lungs, or as an independent affection. A superficial torpid ulcer forms upon the upper surface of the tongue, or the disease begins as a hard lump in the substance of the tongue, which breaks down and forms a deep excavated ulcer. The base of the ulcer is usually yellowish white. The edges are pinkish red, and often soft and friable. There are frequently small secondary nodules in the neighbourhood. The affection is very painful. The treatment is excision of the ulcer. The chances of recovery are not good. These patients usually die of tuberculosis of the lungs or intestine.

Tumours.

The most frequent tumour of the tongue, as well as the most important, is cancer. The disease occurs late in life—from the fortieth to the sixtieth year. Local irritations, pipe-smoking, a jagged tooth, or a chronic localized inflammation or ulceration of the tongue, form the starting point of the disease. The sides and tip of the tongue are the usual seats of the growth, which forms a hard circumscribed lump or a deep excavated ulcer, the edges of which often sprout up into masses resembling a cockscomb. Ulceration develops sooner or later in nearly every case. The growth is usually rapid, and is attended by distressing symptoms. The secretion of saliva is profuse. There is intense pain radiating to the ear. The lymphatic glands on both sides beneath the jaw are soon involved. The discharge from the ulcer decomposes, and the patient's breath has a horrible odour. The jaw becomes fixed, so that the mouth can no longer be opened freely. Death occurs in a year or eighteen months from pneumonia, septicæmia, or exhaustion.

Treatment.

Any chronic affection of the tongue in an elderly person should receive prompt attention. If operated upon at an early period, cure of cancer of the tongue is obtained in about ten per cent. of the cases. Even if the disease returns, life will be prolonged and rendered much more comfortable.

One of the most common of the innocent tumours of the mouth is the so-called *ranula* (a little frog), a translucent sac containing slimy fluid situated under the tongue in the floor of the mouth. The cyst occurs from the plugging of the outlets of certain mucous glands which lie in this situation. The disease causes discomfort from its size. The treatment is to cut out the wall of the sac with scissors. Mere incision does not cure.

Ichthyosis or *leucoma* of the tongue is a chronic inflammatory process, occurring generally in old people. The affected surface of the tongue is converted into a smooth, pearl-grey, shining membrane of variable extent.

The disease is sometimes a forerunner of cancer. The treatment consists in the avoidance of smoking and chewing tobacco, in antiseptic mouth washes, and in the destruction of the affected surface with the actual cautery.

Tongue-tie.

When the little band which extends from the under surface of the tongue in front to the floor of the mouth is too short and reaches too far toward the tip of the tongue, it may interfere with the movements of the tongue in infants and, later on, with speech. When this is the case the band may be cut with a scissors close to the floor of the mouth, not close to the tongue. The operation is seldom necessary and is often done needlessly.

Cleft Palate.

The congenital defect in the hard and soft palate which goes by this name gives rise to more or less serious symptoms, according to the size of the opening which exists between the mouth and the nose. The defect in the roof of the mouth (the hard palate) is situated on one or both sides of the median line. The defect in the soft palate is always central. When cleft palate is combined with harelip it may be very difficult to nourish the infant. Such children can not take the breast. They must be fed from a bottle to which a large, long soft-rubber nipple is attached. Sometimes they must be fed with a spoon. Later on, when the child begins to talk, the voice has a disagreeable nasal quality, or, in some cases, intelligible speech is impossible.

The deformity may be treated by an operation in which the soft tissues on either side of the roof of the mouth are loosened from the bones and sewed together in the median line. The cleft in the soft palate is treated by paring the edges of the fissure and sewing them together. It is customary to wait until the child is five or six years old before operating, a certain degree of intelligence on the part of the patient being necessary to insure success. The defect may also be covered by a hard-rubber or metal plate worn in the roof of the mouth.

Catarrhal and Ulcerative Inflammation.

Catarrhal and ulcerative inflammation of the gums and mucous lining of the cheeks may occur as the result of irritation from diseased teeth, from mercurial poisoning, from want of cleanliness of the mouth, and in the course of fevers. In the catarrhal form the gums and the mucous membrane of the cheeks are swollen and tender; there is an increased secretion of mucus. The treatment consists of cleanliness and the use of antiseptic mouth washes, among others a solution of chlorate of potassium (a teaspoonful to a glass of hot water), peroxide of hydrogen, and potassium-permanganate solution. Painting the gums with tincture of iodine once or twice a day is also of service.

Aphthæ, or *cankers* in the mouth, and the disease known by the vulgar name of "*sprue*," are caused by the growth of a vegetable fungus resem-

bling the yeast plant on the mucous membrane of the cheeks, gums, and tongue. Cankers appear as small white spots on the mucous membrane, surrounded by a narrow inflamed margin. They are quite painful. The spots may be lightly touched with a stick of nitrate of silver. A mouth wash of potassium-chlorate solution, or some other antiseptic mouth wash, should be used every few hours. The mouths of teething children who develop sprue should be washed out several times daily with a solution of boric acid (1 to 50). If the child is nursing, the mother's nipples should be washed with warm water and Castile soap, and then with the same solution after each nursing. The breasts should be covered with a clean cloth to prevent infection from the clothing.

The ulcerative form of inflammation of the gums is common in chronic mercurial poisoning. The treatment is the same as in the catarrhal form. The ulcers may be touched with nitrate of silver or with a solution of chromic acid (two per cent.).

A severe form of ulcerative inflammation of the cheeks and gums is called *noma*. It attacks feeble children, sometimes during convalescence from fevers. The disease is a progressive gangrene of the cheek. It usually begins as a purple or livid spot near the corner of the mouth and rapidly extends, perforating the cheek and often involving the bones of the face. There is apt to be profound constitutional depression, and unless the diseased tissues are removed early and the wound thoroughly disinfected—best with the actual cautery—death will take place from septic poisoning in a few days.

Abscess of the Tonsil—Quinsy Sore Throat.

The symptoms are pain in the throat, swelling, and redness of the soft palate and tonsil. There is fever and prostration, and sometimes a chill at the beginning of the disease. As the swelling of the tonsil increases there is pain and difficulty in swallowing and inability to open the mouth widely. In severe cases breathing may be interfered with.

The treatment is to open the abscess early by a small cut made from above, downward and inward, in the centre of the swelling. The edge of the knife should not be directed outward. As soon as the pus escapes the patient is relieved. An antiseptic mouth wash should be used subsequently.

Enlargement of the Tonsils.

Enlargement of the tonsils, as the result of chronic inflammation, is common among children, and is often productive of serious symptoms. Breathing is interfered with, and the children are unable to get enough oxygen into the lungs. The development of the body suffers in consequence. During sleep the mouth is held open and the children snore. Chronic inflammation of the pharynx is usually present also. The patients are obliged to cough and clear their throats frequently. The accumulation of mucus in the throat

is especially annoying in the morning, and the efforts to get rid of it may lead to vomiting.

The treatment consists of removal of the tonsils by a cutting operation or with the cautery. The treatment of chronic pharyngitis consists in the application of caustics, or of stimulating and soothing applications, according to the necessities of the case.

Decay of the Teeth.

Caries, or decay of the teeth, is caused by the growth of certain microbes in the teeth. The microbes produce acids, which dissolve the earthy material which gives the teeth their hardness, thus destroying the tooth substance. Various causes predispose to decay of the teeth—want of cleanliness and care of the teeth, heredity, severe general diseases, and pregnancy.

The symptoms of caries of the teeth are discoloration, the formation of cavities in the teeth, and toothache. Severe toothache usually does not occur until the pulp cavity is opened. Suppurative inflammation of the pulp gives rise to intense pain and is caused by infection with pus microbes. The disease may lead to the formation of an abscess between the root of the tooth and its bony socket, or to inflammation of the jaw itself.

The treatment of caries of the teeth is to remove the diseased tissue and to fill the cavity with gold, amalgam, or other filling.

Abscess between the Tooth and Jaw.

Abscess between the tooth and the jaw, and inflammation of the jaw itself, usually necessitates removal of the tooth. The pus accumulates between the tooth and the jaw and pushes the tooth partly out of its socket, so that it seems longer. The spontaneous pain is usually severe. It is increased by mechanical pressure. There is often fever. The abscess may perforate between the tooth and the gum or through the gum, or through the skin of the face or neck, or into the antrum of Highmore (a cavity in the upper jaw connected with the nose). Large abscesses in the soft parts may be produced, and occasionally death occurs from septicæmia, pyæmia, or extension of the inflammation to the brain.

After the pus has been evacuated by removing the tooth, or incision, or both, extreme care must be used to keep the mouth clean by the use of mouth washes. If the tooth is not withdrawn, chronic suppuration, with occasional attacks of acute trouble when the outlet for the pus becomes blocked, will be the usual history of these cases. All operative measures upon the teeth should be accompanied by the same painstaking antiseptic measures which are used in the treatment of wounds.

The so-called tartar, composed in part of the salts of lime, which is deposited on the teeth, especially at the border of the gums, should be removed by a dentist as often as it forms. Its accumulation interferes with the nutrition of the teeth and may cause them to become loose and fall out.

For fractures of the lower jaw, see *Fractures*.

CHAPTER VIII.

INJURIES AND DISEASES OF THE NECK.

Injuries of the neck are dangerous on account of the many important structures situated in this region, among them the larynx, the windpipe, the gullet, large arteries and veins, important nerves upon the integrity of which breathing and the action of the heart in part depend, and the spinal column, containing the spinal cord.

Subcutaneous Injuries.

The subcutaneous injuries of the neck occur from blows and falls, from the passage of the wheel of a vehicle over the neck, from assaults in which the neck is violently grasped by the fingers of the assailant, from the application of a ligature around the neck, and from hanging. The injuries produced are of the most varied character. The larynx or the windpipe may be crushed or torn apart. The hyoid bone, which lies just above the larynx, may be fractured.

Symptoms.

The symptoms produced by the injuries to the air passages are pain, often spitting of blood, and mechanical interference with breathing, and sometimes the escape of air into the tissues of the neck, producing diffuse swelling, which crackles on pressure. If unrelieved, death from strangulation may occur very rapidly. To enable the individual to breathe it is sometimes necessary to insert a tube into the windpipe at a point below the level of the injury. This operation is called *tracheotomy.*

In cases where a ligature is tied about the neck, and in hanging, suicidal or otherwise, death occurs from strangulation—*i. e.*, from stoppage of the breathing and from interference with the circulation of the blood in the brain. According to the greater or less suddenness and completeness of the constriction, death may occur very rapidly or be delayed for many minutes. In the former case the face is swollen and livid, the tongue is protruded and often bitten, there is a bloody foam about the lips, the hands are clenched, and the signs of congestion of the surface of the body are marked. The mark of the cord upon the neck is red and depressed. Such a condition is commonly found after judicial or homicidal hanging, and where a cord is suddenly and tightly tied about the neck. In addition there may be extensive laceration of the windpipe and of the muscles and blood-vessels of the neck. The spinal bones may be fractured or dislocated.

Wounds of the neck are more common as the result of attempts at suicide or murder than from other causes. The incised wounds of the neck which are made with a knife or razor with suicidal intent usually

pass obliquely across the neck at the level of or above the larynx. The direction of the cut is commonly from left to right and from above downward. The wound may, but does not usually, sever the internal jugular vein or the carotid artery. The air passages are often opened and many of the smaller blood-vessels may be divided, resulting in fatal bleeding. A suicidal stab wound of the neck often reaches the large vessels. Such wounds are, however, less common. Homicidal wounds of the neck are usually situated, not in the median line of the body, but to one side. There are often several wounds, and they are more commonly punctured than incised. More force is usually employed in their production than when they are self-inflicted. When the common carotid artery or the internal jugular vein are opened, death may take place at once or after several minutes. A special danger from wounds of the neck which open the air passages is the entrance of blood, and later of wound discharge into the windpipe and lungs. Immediate suffocation is often produced by the former, death from pneumonia by the latter. Wounds of the large veins of the neck are dangerous, from bleeding and also from the entrance of air into the open vein. The act of inspiration sucks in the air through the hole in the vein in the same way that air enters the chest through the windpipe in natural breathing. This accident is sometimes followed by sudden death from interference with the action of the heart.

Incised Wounds of the Neck.

To stop arterial bleeding from wounds of the neck temporarily, finger pressure in the wound may be used. In case this is not practicable, the common carotid artery may be compressed against the front of the spinal column at a point below the wound. This artery, which supplies the head and face with blood, lies on the side of the neck beneath the large muscle (the sterno-cleido-mastoid muscle) which passes from the prominent bony point behind the ear to the junction of the collar bone with the breast bone. The course of the vessel is in a line drawn from the junction of the collar bone with the breast bone, to a point midway between the prominent bone behind the ear and the angle of the lower jaw. The vessel is

Treatment.

FIG. 34.—DIGITAL COMPRESSION OF COMMON CAROTID ARTERY.

most conveniently compressed near the middle of the neck. The pressure may be applied with the thumb at the anterior border of the sterno-mastoid muscle, and should be directed backward against the spine (see Fig. 34). *Direct finger pressure is the best temporary means of stopping bleeding from the large veins in the neck.* Pressure of this character in wounds of the neck has been the means of saving a good many lives.

The symptoms and treatment of wounds of the gullet and of the nerves of the neck must be sought for in works on regional surgery.

Infected Wounds of the Neck.

Infected wounds of the neck are particularly dangerous from the possibility of the spread of the inflammation downward into the cavity of the chest. Such wounds should be opened in such a way that the pus has the freest possible outlet. Inflammatory processes of the neck are of frequent occurrence. The lymphatic channels of the scalp, face, mouth, and throat are very abundant, and these parts are constantly exposed to infection of one kind or another. As has been stated, the bacteria of suppuration very commonly spread through the lymphatic channels, and in the lymphatic glands of the neck they very often find a lodgment and produce suppuration. Some of the inflammatory processes of the neck, and frequently the most serious ones, spread by continuity of tissue directly from an inflamed point on the skin of the neck, face, scalp, or mucous membrane of the mouth and throat, sometimes from an abscess at the root of a tooth, or from an inflammation of one of the bones of the face.

Symptoms and Treatment.

The symptoms of abscess of the neck do not differ in kind from abscesses elsewhere. The pain is apt to be severe and the constitutional depression and fever marked. When the abscess is deeply seated there may be little or no redness of the skin for some time, and the swelling may be quite diffuse. *Extreme local pain and tenderness, with fever, will usually point to a correct diagnosis.* In these cases no time should be lost in temporizing measures. The abscess should be opened at once, no matter how deeply it may be situated. By this means, suffering, excessive scarring, and perhaps death from septicæmia will be avoided. Rapidly progressive phlegmon of the neck, characterized by a hard, brawny, diffuse swelling, a purple discoloration of the skin, pain in chewing and swallowing, and great prostration, is a very serious disease. Even under the most energetic treatment extensive necrosis of the skin and subcutaneous tissues is apt to occur, and death from a spread of the infection into the cavity of the chest is not uncommon. The treatment is early and free incisions into the inflamed tissues and energetic disinfection of the wounds.

Acute suppurative inflammation of the parotid gland, the large salivary gland which is situated on the side of the face in front of the ear, occurs as the result of wounds of the gland, but more commonly in the course

of fevers, and in pyæmia and septicæmia. In a large proportion of the cases probably want of attention to the cleanliness of the mouth has much to do with the infection of the gland.

Acute Suppurative Inflammation of the Parotid Gland.

The disease is characterized by high fever, frequently accompanied by delirium, severe pain in the face, fixation of the jaw, and marked swelling. If not opened early the pus finds its way upward or downward, causing sometimes inflammation of the membranes of the brain and death, or, in other cases, a large abscess of the face and neck.

Abscesses beneath the jaw, in the neighbourhood of the submaxillary gland, occur sometimes in the form of an epidemic disease. They have received a special name from the physician who first described the condition—"Angina Ludovici." Fevers, wounds, and septic diseases are also followed by such abscesses. The symptoms are similar to those of abscess of the parotid, but not so severe. The treatment is early incision.

Tuberculosis of the lymphatic glands of the neck has already been described. The remaining enlargements of these glands belong in part to the so-called diseases of the blood—leucæmia and pseudo-leucæmia, to syphilis, and to the domain of tumours—primary in the glands, or secondary to malignant tumours elsewhere. For a description of these conditions the reader is referred to more extensive works on general medicine and surgery.

FOREIGN BODIES IN THE LARYNX.

Portions of food, vomited matter, bones, coins, peas, beans, pins, collar buttons, etc., are sometimes sucked into the larynx. If the foreign body is large enough to close the opening completely and is not expelled by coughing or removed at once, death occurs immediately from asphyxia. In other cases the foreign body may remain in the larynx, giving rise to pain, cough, hoarseness, or loss of voice, and more or less difficulty in breathing. If the foreign body passes through the larynx into the trachea it may be coughed up or remain without producing serious symptoms, or, more commonly, bronchitis, septic pneumonia, and abscess of the lung destroy the individual, unless operative extraction proves successful.

A foreign body which threatens to cause death by choking can often be removed with the tip of the index finger inserted into the throat.

Treatment.

The finger should be protected from the teeth by forcing the handle of a table knife or something similar well back between the molar teeth. If this fails the patient may be inverted and struck smartly between the shoulders. The instrumental removal of foreign bodies from the larynx can only be done by a physician.

The operation of tracheotomy, or the insertion of a tube into the windpipe through a cut in the skin of the neck, is done when some ob-

struction to breathing exists above the point at which the tube is inserted, such as a tumour which projects into or presses upon the trachea; also as a precautionary measure in certain operations which open into the air passages, to prevent the blood from running into the trachea. The operation is also done in order to remove foreign bodies from the trachea and bronchial tubes. In cases of diphtheria the operation is sometimes done to enable the patient to breathe when the larynx is partly closed by false membrane. Instead of this cutting operation, a small tube is sometimes passed through the mouth through the larynx, and allowed to remain *in situ* until the inflammation has subsided. Neither operation has any direct curative effect upon the disease, but either may save life by preventing asphyxia. In order to be of use, these operations should be done before the signs of asphyxiation become marked.

Tracheotomy.

Intubation.

THE ŒSOPHAGUS OR GULLET.

A great variety of substances may be swallowed accidentally or intentionally and become impacted in the gullet. In a large proportion of cases they pass on into the stomach or are vomited. When they remain in the œsophagus the symptoms produced vary with the size and shape of the body. If the foreign body is large, complete inability to swallow may exist, and compression of the trachea may lead to difficulty in breathing. Sharp bodies, such as needles, pins, and bones, may cause severe pain if they become impacted with their long diameters across the œsophagus. The remote results are ulceration of the œsophagus, perforation followed by phlegmonous inflammation of the loose tissues within the chest, and death. Perforation into the trachea, pleura, or lung may lead to septic pneumonia; perforation of the large vessels of the chest, to death from hæmorrhage.

Foreign Bodies in the Gullet.

If the foreign body is situated at the entrance to the gullet it may sometimes be extracted with the finger. When lower down, instrumental extraction will be necessary. It can only be done by a surgeon.

Cancer of the œsophagus occurs in old people. The symptoms are gradually increasing difficulty in swallowing and loss of flesh and strength. The duration of life is from one to two years. In a few cases, where the cancer was situated high up, it has been cut out successfully. An artificial opening is sometimes made into the stomach, through which the patient may be nourished.

Cancer.

THE THYROID GLAND.

The thyroid gland is situated in the neck, just below and on either side of the larynx. Its functions are very important for the health of

the organism. In certain regions a good many children are born with the thyroid gland undeveloped. Such children are semi-idiotic. They do not develop like other children, but remain small and squat of stature. The complexion is pasty; the face is expressionless, heavy, and hideous. These individuals are known as cretins.

Cretinism.

The disease known as myxœdema is caused by wasting away of the thyroid gland. Patients suffering from this disease are melancholy and stupid; the hands, face, and feet are swollen; the skin is rough; the temperature of the body is below normal, and the patients present many of the symptoms of chronic inflammation of the kidneys, for which this disease is often mistaken.

Myxœdema.

Cretinism and myxœdema can be improved and the latter sometimes cured by feeding the patient with the thyroid glands of sheep, or with a glycerin extract of the same.

Goître, or enlargement of the thyroid gland, occurs in several forms. One of these is peculiar to certain regions, notably to some of the valleys of the Swiss Alps, where it seems to depend upon climatic conditions and upon the character of the water. Enlargement of the thyroid gland is also associated with a nervous affection of the heart.

Goître.

True tumours of the thyroid gland are not uncommon. Great enlargement of the thyroid is attended by symptoms of interference with breathing by pressure upon the windpipe. In this country the largest proportion of thyroid enlargements occur as encapsulated cysts. They produce considerable deformity. The treatment of these cysts by other than radical operative removal is uncertain and unsatisfactory. The operation in competent hands results in cure with but slight risk.

Tumours.

CHAPTER IX.

THE THORAX.

Simple contusions of the thorax without injury of the internal organs run a favourable course. The treatment consists of cold, compression, and massage. Severe contusions of the chest, with injuries of the heart, lungs, and great blood-vessels, are very serious. Shock is usually marked. Internal bleeding often proves fatal. If the lung is ruptured there is often spitting of blood. If fracture of the ribs coexists, air is often forced out under the chest wall.

Contusions.

producing a swelling which crackles on pressure. There is difficulty in breathing from the accumulation of extravasated blood within the chest. The treatment is in general the treatment of shock.

For fracture of the ribs, see *Fractures.*

Wounds of the Thorax.

Non-penetrating wounds of the thorax do not present any special peculiarities. Penetrating wounds of the thorax are always dangerous injuries. Wounds of the heart or of the great blood-vessels of the chest are nearly always immediately fatal. Wounds of the lung are dangerous from the possibility of infection and subsequent suppuration. When the wound of the skin is of considerable size, the mere opening of the pleural cavity is attended with some immediate risk from interference with breathing. Air rushes in through the hole in the chest wall, and the lung collapses and can no longer be used for breathing.

Treatment.

The immediate treatment of these wounds is simply to treat them antiseptically. If the patient survives and infection occurs, other treatment may be necessary at a later period. It can only be carried out by a surgeon.

THE BREAST.

Contusions and Wounds; Treatment.

Contusions and wounds of the breast heal readily. In some cases a contusion of the breast may be followed by the growth of a malignant tumour, sarcoma, or cancer. During lactation—*i. e.*, the nursing period—the breast, upon and around the nipple, often becomes fissured and sometimes ulcerated. Such fissures should be carefully cleaned after each nursing with a boric-acid solution, and protected from infection by clean cloths. Ulcers should be touched lightly with a stick of nitrate of silver every two days or so, until healing progresses well. Nursing of the child should be stopped on the affected side and a breast pump used until the fissure or ulcer is cured. Neglect of these precautions often leads to infection with bacteria and abscess of the breast or erysipelas.

Abscesses; Treatment.

Abscesses of the breast occur most often during the nursing period. They are due to infection. A painful, tender swelling is formed in the breast. As the disease progresses, there is fever and more or less prostration, and, when the pus approaches the surface, redness of the skin and the elastic feeling called fluctuation, due to the presence of pus.

If not opened early, such abscesses may spread widely and destroy a large portion of the gland. Occasionally the breast becomes riddled with abscess cavities, and the infection spreads to the loose tissues between the breast and the chest wall. In such cases there is danger of death from

pyæmia and septicæmia, and amputation of the breast may be necessary. *Abscesses of the breast should not be poulticed.*

Tumours. Tumours of the breast occur in considerable variety. Many are malignant or become so; some are benign. They should receive the attention of a surgeon at the earliest possible moment.

THE SPINE.

Fractures of the spine have been spoken of under *Fractures.*

Humpback; Causes and Treatment. Humpback, kyphosis, or angular deformity of the spine occurs as the result of rickets, and from weakness of the muscles and ligaments of the spine; also from disease of the spinal vertebræ, especially from tuberculosis of these bones. (See also *Fractures.*) When due to rickets, the deformity is usually noticed during the second or third year of life. When due to weakness of the muscles and the ligaments, it is most common in poorly nourished girls between the ages of ten and sixteen. In both instances the deformity is rather an excessive bowing of the spine in the upper part of the back than a sharp angular bending such as occurs from fractures and tuberculosis of the bones.

The rachitic form is treated by care of the general health (see *Rickets*), and by allowing the child to lie upon a firm, smooth bed, with the back supported by a suitable cushion. Later on some supporting apparatus may be necessary. The rounded back, which occurs in feeble young girls, is treated by urging the child to walk and sit erect, by suitable exercises, braces, and attention to the general health.

Tuberculosis; Symptoms, Prognosis, and Treatment. Tuberculosis of the spine, which leads to true angular deformity, is most common among children between the ages of three and ten years. The effect of tubercular inflammation on the bones of the spine has already been mentioned. Three important sets of signs and symptoms may be produced: 1. The early symptoms, referable to the changes in the bones themselves and the surrounding soft parts, are as follows: The child is easily fatigued by standing and sitting upright; pain is complained of in the back or belly; there is tenderness over the diseased vertebræ in the back; deformity—*i. e.*, a hump—is gradually developed; the child holds the spine rigid; if asked to pick up something from the floor, the back is held stiff and the body bends forward at the hips; the trunk is supported meanwhile by resting the hands against the thighs; crowding of the vertebræ together by pressure on top of the head causes pain. 2. Pressure on the spinal cord, caused by displacement of the bones, may give rise to complete or partial paralysis of the lower extremities, bladder, and rectum. 3. The formation of tubercular abscesses which are apt to burrow from the force of gravity.

According to the seat of the disease, the abscess may reach the surface in the back of the throat, under the skin of the back, in the lower part of the front of the belly, in the groin, or in the thigh. Rupture of the abscess into internal cavities and organs is less frequent. The disease may prove fatal in a variety of ways, which have been sufficiently indicated already under tuberculosis. Cure, with more or less deformity, is possible at any stage.

The sooner the child is furnished with a suitable supporting apparatus, such as a plaster jacket, the better the chances of recovery and the less the resulting deformity. The general treatment is the same as for the other forms of tuberculosis.

Lateral Curvature of the Spine.

Lateral curvature of the spine, or scoliosis, occurs in several forms and from various causes. The commonest and most important of these is the so-called *Habitual Scoliosis.* It occurs most often in feeble girls between the ages of eight and sixteen years.

Cause.

The deformity develops very often from a habit of sitting improperly at school, especially while writing. The benches upon which children are obliged to sit are often so constructed that a bent and twisted position of the spinal column is favoured. The bones of the spine grow thicker on one side than on the other, and the whole spinal column is twisted or rotated on its long axis. The convexity of the curve is usually to the right, and is commonly situated in the dorsal region—*i. e.*, the region of the ribs. The shape of the chest is also changed. The ribs curve more sharply forward on the convex side, and the size of the chest cavity on that side is diminished. On the opposite side the cavity of the chest is increased in all its diameters except the vertical one. Compensatory curves in the opposite direction are developed in the spinal column, in the neck, and in the loin or lumbar region. The bones of the pelvis may also be twisted out of shape. The muscles and ligaments of the back and chest are lengthened on the convex side and shortened on the concave. After a time these deformities tend to become permanent.

The early recognition of lateral curvature of the spine is of the greatest consequence, for after the deformity is thoroughly developed it is usually impossible to correct it entirely.

Diagnosis.

The first symptom noticed is an elevation of the shoulder on the convex side of the curve and an undue prominence of the shoulder-blade on the same side. The opposite hip is more prominent. The spine itself may show little or no apparent deviation from a straight line at this time.

When these signs are noticed the child should be put under treatment without delay. Physical exercise out of doors, gymnastics, and abundant

food are important. The child should sit upon a proper seat while studying and writing, and in such a position that the spine may be held straight without discomfort. The sitting posture should not be maintained too long. It is well that such children should lie supine upon a hard bed for an hour or more during the middle of the day.

Treatment.

When the deformity is already developed other treatment is necessary. The child is suspended by the shoulders and neck so that the weight of the body overcomes the curvature of the spine as far as possible. In this position a plaster-of-Paris corset is applied, which is renewed from time to time as the deformity grows less.

For a description of the numerous exercises and apparatus used in the treatment the reader is referred to works on orthopædic surgery.

CHAPTER X.

INJURIES AND DISEASES OF THE ABDOMEN.

General Considerations.

Contusions and wounds of the abdomen, in which the injury is confined to the wall of the belly, the cavity itself and its contents remaining unopened and uninjured, are of no more serious import than similar injuries elsewhere. When, however, the peritoneal or belly cavity is exposed to infection through an external wound, or through a wound or rupture of the intestine, stomach, or urinary bladder, a most serious condition exists, in which even the most prompt and careful treatment may fail to save life. In these cases death is caused by internal bleeding or by acute general suppurative peritonitis—*i. e.*, suppurative inflammation of the lining of the belly and of the outer or peritoneal surface of the abdominal viscera.

CONTUSIONS AND WOUNDS OF THE BELLY WALL.

Contusions of the belly wall are attended, as elsewhere, by rupture of a certain number of blood-vessels and by black-and-blue marks. The treatment consists of cold, pressure, and massage.

Wounds of the belly wall, when they do not penetrate into the cavity of the peritonæum, are treated with ordinary antiseptic precautions. When muscles are divided it is very important that their divided ends should be sewed together, to prevent a weak place in the abdomen through which some part of the abdominal contents may subsequently protrude, forming a hernia. See *Hernia.*

INJURIES OF THE ABDOMINAL CAVITY AND ITS CONTENTS.

Severe contusions of the abdomen may cause rupture of any of the contents of the belly and death from internal bleeding, or, when a portion of the intestinal tract is ruptured, escape of its contents may take place, causing a rapidly fatal peritonitis.

Symptoms.

Such injuries, when caused by a blunt instrument, such as a heavy club, wagon-pole, hoof of a horse, etc., or by falling or being thrown against some solid blunt object, as a post or projecting piece of stone, are usually, but not always, attended by shock. When the general symptoms of bleeding appear, or peritonitis makes itself manifest (see *Peritonitis*), a surgeon will in suitable cases open the belly, tie off the bleeding points with catgut, or sew up the torn intestine, stomach, or other ruptured organ, and clean the peritoneal cavity. If the operation is done early many lives can be saved in this manner.

In the absence of a surgeon, severe contusions of the abdomen should be treated by stimulants when necessary to combat grave symptoms of shock. An ice bag should be placed over the contused region, and opium should be given in full doses to keep the intestines quiet and thus tend to prevent the escape of their contents and promote healing. It should be understood that Nature makes an attempt, sometimes successful, to prevent the escape of the contents of the ruptured stomach or bowel by the rapid formation of adhesions between the torn portion and the peritoneal covering of the belly wall, or the surface of some other organ. These adhesions form very rapidly and may seal up the opening in twenty-four hours. If Nature's effort is only partly successful, a localized abscess may be produced, surrounded by adhesions which shut it off from the general cavity of the peritonæum. Such abscesses can often be opened successfully. If the stomach and bowel are comparatively empty at the time of the accident, the chances of such adhesions forming are much better than when these organs are distended with food and gas.

Penetrating wounds of the abdomen may open into the peritoneal cavity merely, or affect also one or other of the abdominal viscera. To the dangers spoken of under contusions are added the risk of infection from without through the wound in the belly wall.

Treatment.

The treatment of such wounds in the absence of a surgeon may be stated in a few words. If gas and intestinal contents are seen to escape through the wound, give opium enough to quiet pain. The patient will almost surely die. If a portion of the intestine has escaped through the wound and is opened so that its contents are escaping externally, pull out enough of the gut to be sure that no intestinal contents can get into the belly. Pack the space between the

edges of the wound and the gut lightly with clean gauze and give the patient moderate doses of opium. If there is no other wound of the gut, recovery may take place with the formation of an *artificial anus*, as it is called, which may be subsequently closed by operation. If the gut or any other organ protrudes through the wound, but is not itself wounded, clean it with boiled water and push it back into the belly. The part which came out last should be pushed back first. Give opium in moderate doses. If an organ protrudes and is wounded so that it bleeds it should be left outside, cleaned with boiled water, and the hæmorrhage stopped by pressure with gauze packing. It may be replaced by a surgeon later. In all cases a large antiseptic dressing should be applied, and the body surrounded by a broad bandage extending from the hips to the chest, and held in place by pins. The skin around the external wound should be disinfected as thoroughly as possible; but never allow corrosive sublimate or any other strong antiseptic to enter the cavity of the belly.

The treatment of gunshot wounds of the abdomen in the absence of a surgeon is to clean the external wound, apply an antiseptic dressing, and give full doses of opium.

When in doubt as to whether a wound penetrates into the belly or not, do not explore it with either finger or probe; clean it, apply a dressing, and await developments.

In all cases of severe injury to the belly, food should not be given by the mouth for the first twenty-four or thirty-six hours. Thirst may be quenched by allowing the patient to swallow small pieces of ice whole. Whiskey may be given by the rectum in small doses as often as necessary to support the patient's strength.

PERITONITIS.

Inflammation of the peritonæum in its acute form, which alone will be considered in this article, occurs from a variety of causes. Chief among them are wounds such as we have spoken of; also surgical operations on the interior of the abdomen in which strict antisepsis has not been observed; further, ulcerative processes in the alimentary canal which perforate the wall of the gut and allow the escape of its contents into the peritoneal cavity. Among these processes may be mentioned typhoid fever, perforating ulcer of the stomach, and inflammation of the vermiform appendix. Infection of the peritonæum may also occur by direct extension of inflammation from any of the abdominal organs or from the spine or the cavity of the chest.

Causes.

Peritonitis sometimes occurs as a complication of pyæmia, septicæmia, and in the course of the eruptive fevers. According to the severity of the process, the inflammatory product which is poured out

into the peritoneal cavity may consist of watery fluid, of watery fluid and fibrin, or of pus with more or less fibrin and watery fluid added thereto. The purulent variety is the one which chiefly interests surgeons, and that alone will be described. We distinguish (1) a diffuse purulent peritonitis in which the whole or the greater part of the peritoneal cavity is inflamed; (2) a form in which Nature partly succeeds in limiting the inflammation by an exudation of fibrin and the formation of adhesions around the inflamed area, but where the inflammation continues to spread more or less rapidly and becomes general after a variable time unless promptly treated; (3) a form in which the limiting adhesions shut off the pus completely from the general cavity. This form, too, may become general from rupture of the abscess into the healthy peritonæum. In other cases rupture takes place into the gut, or the pus may finally perforate the abdominal wall and escape externally.

Diffuse purulent or septic peritonitis following perforation of the gut from any cause, or due to infection of a wound of the peritonæum, runs in some cases a very rapid course; the pus microbes develop so large a dose of poisonous material that the individual succumbs to the constitutional infection in one or several days without any very marked changes in the peritonæum taking place. In other cases a more or less copious exudation of pus and fibrin is produced. The former tends to gravitate to the pelvis, and to form large purulent collections in this region. Once fairly started, these two forms of peritonitis are rarely recovered from under any form of treatment. Less fatal and more amenable to treatment are the slowly progressive form and that in which a circumscribed abscess is produced. A small proportion of the cases of general purulent peritonitis when operated upon at an early period do recover, but their number is small and will probably remain so.

Symptoms.

A prominent symptom of all cases of purulent peritonitis is vomiting. The vomited material is usually of a green colour, and in the later stages of the disease may resemble the contents of the lower bowel. There is sometimes a chill at the beginning of the disease followed by fever, which may rise in a few hours to 104° or 105° Fahr., and usually remains elevated until death or recovery. In some of the most rapid and severe cases, however, the temperature may be but little elevated, or even below the normal. The pulse is frequent —110 to 140 beats to the minute—and feeble. The belly is swollen from distention of the intestine with gas. In bad cases the swelling may become extreme. There is intense spontaneous pain in the abdomen, which may be referred to the site of the inflammation or not. There is great tenderness on pressure over the abdomen. During the early stages of the disease the tenderness is often greatest over the point whence the in-

flammation started. Absolute constipation exists in the majority of cases. In severe attacks the face has a pinched and drawn appearance, and is of an ashen-grey colour. The eyes are sunken.

Causes: Inflammation of the Vermiform Appendix, or Appendicitis.

Among the commonest causes of peritonitis is inflammation of the vermiform appendix. This little organ, which is represented in some of the lower animals by a large blind pouch connected with the large intestine, and serving the purpose of a storehouse for food, has in man outlived its usefulness. It is situated on the right side of the belly, low down, near the junction of the small with the large intestine, of which latter it forms a part. The appendix is a hollow tube about as large around as a lead pencil, and varying in length from an inch to five or more inches. It empties at its base into the large intestine. The tip is closed.

Involution.

The vermiform appendix is an organ which is undergoing involution, as we say—that is, in man it has ceased to be of use, and shows signs of imperfect development and of other changes which probably presage complete disappearance in the course of time. For example, in a certain proportion of cases it is represented by a little cord without any canal in its interior. In other cases it is bent upon itself at a point a little way removed from the large intestine. This bending causes a narrowing of the calibre at that point.

Foreign Bodies.

Little masses of dried and hardened intestinal contents are apt to form in the interior of the appendix. Whether from loss of functional activity, or from the narrowing of its calibre, or from the presence of little hard masses within it, or from all these causes combined, it frequently happens that the contents of the appendix become dammed up in its interior and can not escape into the large intestine. The circumstances are now favourable for an attack of inflammation. The idea that cherry-stones, grape-seeds, and the like are a frequent cause of appendicitis is not borne out by experience. Such bodies are occasionally found in the appendices of those who have died of other diseases, and rarely in cases of inflammation of the appendix, but there is no good reason for believing that they exercise an influence in the production of the disease.

Obstruction.

No matter how produced, obstruction of the calibre of the appendix favours inflammation by producing congestion of its mucous lining, thus creating a good soil for the growth of those bacteria which regularly inhabit the large intestine. The mere mechanical pressure of a hardened mass of intestinal contents may produce a place of diminished resistance, or even necrosis of the mucous membrane and an ulcer.

The character of the inflammation varies in different cases. In a large

proportion of these a catarrhal inflammation results. The appendix becomes distended with catarrhal secretion, but finally succeeds in emptying itself into the large intestine.

Symptoms and Outlook.

The symptoms of such an attack are pain in the abdomen, which may be general at first, or confined to the region of the stomach, or in many cases there is pain from the beginning of the disease in the right side of the belly, low down, a little above the brim of the pelvis. Local tenderness is always present, and is often most marked at a point midway between the navel and the prominent bony point which can be felt at the front of the crest of the haunch bone or ilium (the anterior superior spine of the ilium; see article on *The Anatomy of the Human Body*). In some cases a distinct swelling can be felt in this region, and the belly will be found more rigid on the right side. In addition the patient will usually have fever, and the pulse will be increased in frequency. There is often constipation and very often vomiting. In favourable cases the symptoms will all subside in a few days—as soon as the obstruction has been overcome. In cases where the inflammation has been a little more intense a slight amount of fibrinous exudation takes place from the peritonæum near the appendix. There will often be a distinct tumour in the region of the appendix. The attack lasts a little longer, and the patient suffers from pain and tenderness in the region of the appendix for weeks or months. The fibrin is partly supplanted by fibrous tissue, and the appendix is thus rendered adherent to the surrounding structures.

In cases where the inflammation is so severe that ulceration and perforation of the wall of the appendix takes place, the symptoms vary according to the rapidity of the ulcerative process and the behaviour of the peritonæum. If the ulceration takes place slowly the peritonæum will begin to pour out fibrin and to form limiting adhesions before perforation is complete. And when perforation does occur, the general cavity of the peritonæum will be shut off and a localized abscess will be produced. The attack may begin mildly, but the patient will become continually more ill instead of better. All the signs and symptoms will increase in severity, and the abscess will continue to increase in size until it bursts in one of several directions—for example, through the skin, into the intestine, urinary bladder, genital tract of the female, cavity of the thorax—or until the patient dies of septicæmia. When the perforation is a little more rapid a progressive peritonitis may be set up, resulting in death unless operated upon early. In the worst cases sudden perforation takes place, apparently within a few hours or a day or two from the beginning of the attack. In these cases there may be no adhesions formed to limit the spread of the poisonous material, and the patient may suddenly have very severe pain in the abdomen, pass into a condition of shock

from which he does not rally, or develop all the signs of diffuse purulent peritonitis. Still another form of inflammation may occur in the appendix. The whole or a part of the organ may undergo gangrene from the severity of the infection. These cases usually run a rapid course. They sometimes result in a localized abscess, but are quite often attended by progressive or diffuse peritonitis and a severe form of septicæmia. The milder forms of the disease are apt to recur from time to time. Each succeeding attack may be milder or more severe than the last, and any one of them may result in perforation and the formation of an abscess, or death from peritonitis. In some cases repeated attacks probably end in cure by obliteration of the calibre of the appendix. In other cases the patient has one severe attack after another at more or less frequent intervals, and suffers more or less pain and discomfort a good deal of the time, so that his health is impaired in consequence, and he is no longer able to carry on his affairs with comfort and regularity.

Treatment.

While in any given case the question of operation must be decided by a surgeon, it may be said in general that, in those cases where the symptoms point to perforation and peritonitis, to gangrene of the appendix, or to the presence of an abscess, immediate operation offers the best chance of recovery. In cases where repeated attacks of moderate severity occur, but at rather frequent intervals, and where considerable discomfort is present between the acute attacks, the majority of surgeons agree that removal of the appendix during a quiescent interval is attended by slight risk only, and is preferable to non-interference.

When performed during an acute attack, and where the presence of pus is certain or probable, the abdomen is opened by a cut over the situation of the appendix. Great care is taken during the evacuation of the abscess to prevent infection of healthy peritonæum. To this end a small opening is made into the abscess at first, through which its contents are allowed to escape slowly, sponges being used to mop up the pus a few drops at a time. The surrounding intestines are protected by pads of gauze or sponges. The abscess cavity is finally wiped dry and clean, and the appendix is sought for and removed if practicable. When diffuse peritonitis exists the abdomen is sometimes washed out with a weak, hot solution of boiled salt and water. In every case where pus is found the wound is packed with strips of gauze and left open. In some cases a large glass drainage-tube is inserted into the most dependent portion of the peritoneal cavity. When the operation is done in the interval between two attacks, and no pus is found, the appendix is removed and the wound closed with stitches. In these cases the muscular layers of the belly wall are sometimes split and not cut across, in order to avoid a sub-

sequent weak place in the abdomen, which is very apt to follow the transverse division of the muscles.

The chances of recovery from operations done during an interval between two attacks are excellent. The percentage of deaths is very small. When done for a localized abscess, the chances of recovery are also very good indeed, but when diffuse peritonitis is present recovery is, as already stated, very rare.

FOREIGN BODIES IN THE ALIMENTARY CANAL.

Foreign bodies may gain access to the alimentary canal through the mouth, or through the anus, or through a wound in the abdomen, or a gallstone may ulcerate through the gall bladder and wall of the intestine. Occasionally concretions are formed in the intestine consisting of the salts of lime and magnesia. Such concretions may be formed around a gallstone, or a cherry or peach pit as a nucleus. Insane and hysterical persons sometimes swallow intentionally foreign bodies of various kinds in large numbers, such as needles, pins, knives, forks, spoons, etc. Only foreign bodies which have been swallowed will be spoken of here.

Symptoms.

The larger the foreign body, and the more irregular its shape, the more likely it is to become impacted and cause trouble. In a great majority of instances, however, no symptoms are produced, and the foreign body is passed through the lower bowel without difficulty. When such is not the case, the foreign body may remain in the stomach or become impacted in some part of the intestine. The symptoms of impaction are pain, and sometimes the symptoms of acute obstruction of the bowel. If ulceration and perforation occur, the formation of a localized abscess or diffuse purulent peritonitis is the result.

Treatment.

Purgatives should not be administered. The patient should be fed on mashed potatoes in large amount. In this way the foreign body will be inclosed in a mass of soft material and will be much less likely to injure the intestine. In case the foreign body is not passed, and pain and tenderness of the abdomen develop, opium should be given in moderate doses and a surgeon should be called at once. It may be necessary to cut down upon the foreign body and remove it.

INTESTINAL OBSTRUCTION.

Obstruction of the bowel may occur from many causes. The obstruction may be acute or chronic. The condition is one of mechanical stoppage of the bowel such that its contents can not pass.

Among the causes of acute obstruction are: The presence of foreign bodies in the gut; twists in the bowel; fibrous bands which constrict the

gut; herniæ (see *Hernia*); the condition known as *intussusception*, in which one portion of gut becomes invaginated into another. Acute obstruction occurs most often in the small intestine. The condition is an absolutely fatal one in a few days unless relieved.

Acute Obstruction; Causes.

The symptoms are absolute constipation; frequent and distressing vomiting; distention of the abdomen from the accumulation of gas in the intestine; pain in the abdomen of a spasmodic character, less continuous and less intense than in peritonitis; and tenderness of the abdomen, also less severe than in peritonitis. The vomited matters consist at first of the contents of the stomach, later of the contents of the bowel above the seat of obstruction. The vomited matter is usually of a dark colour and emits a fetid odour. There is sometimes fever. The pulse becomes more and more rapid and feeble, and unless the obstruction is relieved the patient passes into a condition of collapse and dies.

Symptoms.

Purgatives should not be administered. Large injections of soap and water into the rectum, made slowly and gently with a fountain syringe, while the patient rests upon his elbows and knees, may be tried. A surgeon should be seen at once, since a delay of twenty-four hours may render the case hopeless. Operation for the relief of acute intestinal obstruction, if undertaken early, offers a fair prospect of saving life. If delayed until the patient is exhausted and the bowel paralyzed by overdistention, recovery is very rare.

Treatment.

Chronic intestinal obstruction occurs most often in the large intestine as the result of cancer of the gut, sometimes from fibrous strictures which gradually encroach upon the calibre of the canal, and occasionally from chronic invagination of the bowel. In old people, accumulation of intestinal contents in the large intestine may simulate chronic intestinal obstruction.

Chronic Obstruction; Causes.

Gradually increasing difficulty in procuring a natural evacuation of the bowels is regularly present. There may also be diarrhœa from time to time, due to catarrhal inflammation of the gut above the seat of obstruction. As the passage grows narrower, swelling of the abdomen and colicky pains are developed. Death occurs from exhaustion or from acute obstruction.

Symptoms.

The only possible relief in these cases is to be derived from operation. The operation may aim to cure the condition. In this case the diseased portion of gut is cut out and the healthy ends sewed together. Or, if this is found to be impracticable, the disease may be left *in situ*, and the healthy gut above and below the obstruction may be joined together in one of several ways, thus switching off, so to speak, the diseased part from the rest of the canal. When the

Treatment.

obstruction is situated low down in the large intestine, an artificial opening may sometimes be made through the abdomen or loin into the gut above the obstruction. The edges of the opening in the gut are joined to the skin and the contents of the bowel are allowed to escape through this *artificial anus*, as it is called.

In old people who suffer from accumulation of fæces in the large intestine there is often a long history of constipation followed by diarrhœa. The dilated intestine can often be felt filled with large doughy masses through the abdominal wall. Examination of the rectum with the finger shows it to be filled with hardened fæces. The treatment is to remove the contents of the rectum with the fingers or with a spoon, and to clean out the remainder of the large intestine by copious enemata. To prevent subsequent attacks, stimulating laxatives should be administered regularly. Massage of the belly is also of use.

INJURIES AND DISEASES OF THE ANUS AND RECTUM.

Wounds of the Anus and Rectum.

Wounds of the anus and rectum other than those made during surgical operations are comparatively rare. They sometimes occur from impalement upon a sharply pointed object such as a fence picket, upon which the individual falls in a sitting posture; occasionally from being gored by a bull. Lacerations of the vagina and rectum are not uncommon during labour. Wounds which extend deeply into the rectum may penetrate into the peritoneal cavity and be attended by fatal peritonitis.

Bleeding from wounds of the rectum is often dangerous, the more so because the blood may accumulate in the gut and not escape outwardly, and the bleeding may thus be unsuspected.

While uncomplicated, wounds of this region usually heal readily, in spite of the contact of the contents of the bowel with the raw surface, yet a surgeon or physician will alone be able to determine the gravity of the injury, and hence inspection by such a one is desirable in every case.

Foreign Bodies in the Rectum; Treatment.

Foreign bodies in the rectum may have been swallowed or introduced through the anus. When large and irregular in shape they may become impacted and give rise to pain, constipation, or complete obstruction. In some cases ulceration and perforation into the peritonæum, urinary bladder, or vagina may occur.

If the foreign body fails to pass naturally, it may sometimes be extracted with the fingers. If not, a surgeon must be called.

PAINFUL FISSURE OF THE ANUS.

As the result of slight tears in the mucous membrane of the anus from the passage of hardened fæces, a shallow, chronic ulcer may be produced

just within the grip of the sphincter muscle. The affection is a very painful one. The very sensitive nerve endings of the part are exposed on the surface of the ulcer. During each movement of the bowels these nerves are irritated, and the sphincter muscle is thus thrown into a condition of spasm. The pain produced thereby is severe, and is felt not so much at the time the bowels are moving as afterward—often for several hours. After the bowels move there may be the escape of a few drops of blood. These individuals often believe that they are suffering from piles.

Treatment.

The bowels should be kept freely opened, and if the ulcer is very small a few applications to its surface of a solution of nitrate of silver—twenty to forty grains to the ounce of water, at intervals of two or three days—may effect a cure. If this fails the disease can be surely cured by cleaning out the bowels with a brisk cathartic, giving the patient ether, and stretching the sphincter muscle widely with the thumbs of both hands inserted into the bowel. A knife is sometimes drawn lightly through the base of the ulcer also. By this operation the sphincter muscle is completely paralyzed for some days. The sensitive nerves are relieved from irritation and the ulcer heals rapidly.

HÆMORRHOIDS (PILES).

Cause, Varieties, Symptoms.

Hæmorrhoids are commonly the result of chronic constipation. Any condition which produces congestion of the lower bowel, such as pregnancy, large tumours in the pelvis, displacements of the uterus, diseases of the liver and of the heart, predisposes to their occurrence. They consist of little tumours of a blue or dark-red colour composed chiefly of dilated veins, which appear either just at the margin of the anus, partly within the sphincter muscle, or higher up, well within the bowel and above the external sphincter muscle. The symptoms and importance of these two varieties vary.

External Hæmorrhoids.

The first or external form of hæmorrhoid is a more or less tender, painful tumour which rarely bleeds, and causes generally merely a moderate degree of pain and annoyance. The pile can be seen and felt at the margin of the anus as a dark-blue swelling which never retreats into the bowel. Attacks of acute inflammation occur in such piles. There is often considerable fever and constitutional depression and intense pain. The pile becomes swollen, hot, red, tender, and very painful. It may even suppurate.

Treatment.

During an acute attack of inflammation there is nothing better than rest in bed and the application of a large pad of gauze wet with lead-and-opium wash, the formula for which was given under *Erysipelas*. If suppuration occurs the abscess must be opened. Radical cure of these piles by cutting them off with a scissors is simple. The operation can often be done with cocaine.

Internal piles are much more serious. In such cases the principal symptom is bleeding, which may be so excessive that the patient's strength is greatly reduced thereby. The bleeding may be almost constant, but usually takes place only when the bowels move. At this time the piles often protrude from the anus. They may become greatly swollen so that their reduction becomes impossible and gangrene of the mass may result, sometimes accompanied by grave symptoms of septicæmia or by pyæmia.

Internal Hæmorrhoids.

The *palliative treatment* of internal piles consists in the avoidance of constipation by the use of laxatives and the cultivation of regular habits in regard to the action of the bowels. A sedentary life and excessive eating and drinking are to be avoided. The *curative treatment* consists in the operative removal of the piles by one of several methods, for a description of which the reader is referred to works on diseases of the rectum. When properly performed, the operation is not dangerous, and cure is usually effected.

Treatment.

FISTULA IN ANO.

A perforating ulcer within the rectum or an abscess close to the rectum which is opened through the skin, or bursts into the rectum, or externally, or both, is the cause of this condition. When formed, the disease presents three varieties. There may be an unnatural passage through the tissues which communicates at one end with the rectum and ends at the other in a hole in the skin near the anus. This is called a *complete fistula.* There may be an opening in the rectum and none in the skin. This is called a *blind* or *incomplete internal fistula.* There may be an opening in the skin and none into the rectum. This is called a *blind* or *incomplete external fistula.* A certain number of these fistulæ are tubercular in character. Such are commonly associated with tuberculosis of the lungs and intestine.

Varieties and Cause.

The disease is essentially a chronic one, and gives rise to much pain and discomfort. When an external opening exists, more or less pus escapes through it. When the fistula is complete, gas and semifluid intestinal contents find their way through the external opening from time to time.

Symptoms.

The treatment of fistula *in ano* of all three varieties is the same. It consists of stretching the sphincter muscle and dividing the tissues which intervene between the canal of the fistula and the gut. The unhealthy tissue which lines the fistula is then scraped or cut away and the wound kept as clean as possible until it heals from the bottom. Other forms of treatment are of doubtful efficacy.

Treatment.

The treatment of tubercular fistula *in ano* is the same, unless the dis-

ease of the lungs is far advanced and progressive, when palliative measures should be used.

CANCER OF THE RECTUM.

This disease occurs after the fortieth year of life. The symptoms come on gradually. They are constipation, a bearing-down feeling and straining at stool, a discharge of blood and mucus from the bowel, and severe pain. The stools have sometimes a ribbonlike shape. Diarrhœa occurs from time to time. The diagnosis is made by inserting the finger into the rectum, when a hard, often ragged mass will be felt within the bowel, which narrows its calibre so that often the finger can not be passed through it. These patients gradually lose flesh and strength, and die after intense suffering from exhaustion or extension of the disease to other organs.

Symptoms and Diagnosis.

In a certain proportion of cases the diseased portion of the rectum can be cut away with success. A number of cures have resulted from the operation. When this is not practicable on account of the size or high situation of the growth, an artificial anus may be made on the left side of the belly low down or in the loin. This operation gives the patient great relief and prolongs life.

Treatment.

HERNIA (RUPTURE).

The unnatural protrusion of an organ through the wall of a cavity which normally contains it is called hernia. In the case of the organs of the belly the condition is vulgarly known as *rupture.* Hernia of the abdominal organs occurs in many situations. There are three in which it is far more frequent than the rest: First, inguinal hernia. The intestine usually, or occasionally some other organ, protrudes through the canal which normally exists in the inguinal region or groin for the passage of the testicle and spermatic cord in the male, and the round ligament in the female, pushing a pouch of peritonæum in front of it, which subsequently becomes what is known as the *hernial sac.* A swelling is thus produced in the groin, or in some cases the hernia travels farther downward into the scrotum of the male, or into the labium majus of the female. This is the most frequent form of hernia. It is much more common in men than in women. Second, femoral hernia. The hernial protrusion takes place into the thigh along the inner side of the great blood-vessels where they pass from the abdomen to the thigh. The tumour appears below the fold which separates the thigh from the abdomen, at the junction of the front with the inner surface of the thigh. About one tenth of all herniæ are of this variety. It is more common in women than in men. Third, um-

Definition.

Inguinal Hernia.

Femoral Hernia.

bilical hernia. The protrusion takes place through the navel. This form of hernia occurs chiefly in infants and in middle-aged, fat women. There are numerous other situations in which herniæ occur, and each form of hernia has several anatomical varieties, for a description of which the reader is referred to works on surgery.

Umbilical Hernia.

The symptoms of hernia are the sudden or gradual appearance of a tumour in one of the situations above specified. There is often a dragging feeling in the abdomen and a moderate amount of pain and discomfort at the site of the hernial protrusion. If untreated, a considerable part of the intestine may descend into the hernial sac and give rise to a good deal of discomfort and deformity from the mere size of the swelling. In the majority of cases when recent, and in some cases throughout the life of the individual, the protruded organs can be replaced by pressure in the recumbent position. In many cases, however, if the hernia be habitually allowed to remain unreduced, adhesions form between the intestine or other organ and the sac which contains it. The hernia can then no longer be pushed back into the belly, but remains permanently outside in the hernial sac.

Symptoms and Prognosis.

The mere displacement of the organs contained in a hernia does not in itself constitute a dangerous condition, but every individual who goes about with an unreduced hernia has nevertheless a sword constantly over his head. He runs a grave risk of having his hernia become *strangulated*, which means simply this: From causes which it is here needless to describe the contents of the sac get pinched at the point where the hernia emerges from the belly, and when this occurs the tumour can no longer be replaced. If it be a loop of intestine which is thus constricted, the patient suddenly has severe pain, becomes very ill, develops all the symptoms of obstruction of the bowel, and, if not relieved, the contents of the hernial sac become gangrenous, and the death of the individual is usually a matter of a very few days.

The diagnosis of hernia is based chiefly upon the situation of the tumour, upon the fact that often it can be pushed back into the belly, and upon a decided expansive impulse transmitted to the hand which grasps the tumour when the patient coughs.

Diagnosis.

The diagnosis of strangulated hernia is based upon the presence of a tender painful swelling in one of the situations in which herniæ occur, and usually upon the presence of the symptoms of intestinal obstruction. There is no impulse on coughing.

Strangulated hernia can sometimes be reduced by gentle manipulation of the tumour. This method is not practised at present except where the hernia has been strangulated only a few hours and goes back after

the gentlest manipulation. The administration of ether or chloroform greatly facilitates reduction. When strangulation has existed for many hours this method is dangerous; a perforated or gangrenous loop of intestine may be pushed back into the belly, or the manipulations may cause a rupture of the already weakened wall of the intestine, or such additional injury that perforation takes place after reduction has been accomplished. In all of these instances death is almost certain to occur from peritonitis.

Treatment of Strangulated Hernia.

In case the strangulation is not very recent, the safest procedure is an operation performed at the earliest possible moment. A cut is made over the hernia, the sac is opened, the point of constriction is found, and the constricting band is divided. If, now, the strangulated intestine resumes its normal appearance with the return of blood to its vessels, it is replaced in the abdomen and the wound closed by stitches in one of several ways. If the gut is perforated or gangrenous, it is either left *in situ* to slough off with the formation of an artificial anus, or the gangrenous part may be cut away and an artificial anus established at once; or, the gangrenous portion having been removed, the healthy ends of the gut are united by stitches and returned to the abdomen; or the gangrenous portion is left *in situ*, the belly is opened by another cut, and a loop of intestine above the gangrenous portion is united to one below. Each of these methods has its advantages in special cases. A choice is determined by the local and general condition of the patient and the operative skill of the surgeon.

The treatment of non-strangulated hernia is of two kinds. In reducible hernia, a belt having a pad attached which presses upon the hernial orifice and prevents the descent of the hernia is worn during the day and removed at night. Such a belt is called a truss. It should keep the hernia from escaping under all circumstances, and should be comfortable. In very young subjects this treatment may result in cure. When the hernial orifice is very large, and in irreducible herniæ, its application may be impracticable. The other form of treatment is operation. The object to be attained is obliteration of the sac into which the hernia descends, and closure of the wound in such a manner, by means of stitches, that the hernia can not recur. The fulfilment of this latter aim has occupied the attention of surgeons throughout the world. Many operations have been devised for the cure of hernia. None up to the present time can be said to accomplish the desired result in every instance. Those which have hitherto given the best results are the operation of Bassini, of Italy, and that of William S. Halsted, of Baltimore. For a description of them the reader is referred to recent works on surgery. A very large propor-

Treatment of Non-strangulated Hernia.

tion of cases are thus cured—*i. e.*, the hernia does not recur, and the patient is not obliged to wear a truss.

Indications for and against Operation.

The indications for operations on hernia are, first, strangulation; second, inability to retain the hernia with a truss; third, when the hernia is irreducible and the individual is prevented from pursuing his occupation in consequence thereof, or is subjected to pain, disturbances of digestion, and attacks of inflammation in the hernial sac, or where new portions of intestine come down from time to time which can not be kept replaced; fourth, among labouring men, who often neglect themselves and fail to wear constantly a properly fitting truss.

The contra-indications to operation are, first, chronic alcoholism; second, a very lax, fatty, and flabby condition of the tissues of the abdominal wall; third, diseases which render any surgical operation more dangerous, such as chronic disease of the kidneys, diabetes, etc.; fourth, in cases of very large and ancient hernia in which it may be impossible to replace the intestine in the contracted abdominal cavity.

HYDROCELE.

Symptoms.

A chronic inflammation of the sac which incloses the testicle, attended by the gradual accumulation of watery fluid within the sac, is called *hydrocele.* The symptoms produced are chiefly discomfort from the size and weight of the accumulation. The diagnosis is made from the fact that the swelling is translucent when interposed between the eye and a bright light. There is no impulse on coughing.

Treatment.

The treatment is palliative, by drawing off the fluid through a hollow needle, after which it may be expected to reaccumulate; or curative, by opening the sac, destroying its inner surface with iodine or carbolic acid, partly closing the wound by stitches, and allowing the central portion of it to heal from the bottom. Confinement to bed for a week or ten days is necessary after the operation.

VARICOCELE.

Symptoms.

Enlargement of the veins of the spermatic cord has received this name. The enlarged and tortuous veins can be felt and often seen in the scrotum, resembling a bunch of worms. Dragging pain is felt in the testicle, and sometimes there is wasting of this organ. The disease usually occurs upon the left side. A considerable degree of nervous apprehension and melancholy sometimes accompanies this condition.

The treatment is palliative, by means of a suspensory bandage which

supports the testicles, cold baths, physical exercise, and tonics; and curative, by operative removal of the veins. The best and easiest operation, in the opinion of the writer, consists in cutting out an inch or more of the dilated veins and sewing the two stumps together, thus creating a natural suspensory bandage. The wound heals very rapidly.

Treatment.

CHAPTER XI.

THE UPPER EXTREMITY AND AXILLA (THE ARMPIT).

The fractures and dislocations in the neighbourhood of the shoulder joint have already been mentioned.

The most important tumours which occur in the vicinity of the shoulder joint are rapidly growing, malignant sarcomata of the humerus. Amputation at the shoulder joint is the only treatment.

Fig. 35.—Line showing the course of the brachial artery.

Fig. 36.—Digital compression of the brachial artery.

For contusions, sprains, and inflammations of the shoulder joint, see *Joints*.

The main artery (the brachial) and veins of the upper extremity lie upon the inner side of the limb. The course of the artery is indicated, when the arm is held at right angles to the trunk, by a line drawn from the bony point which can be felt just beneath the collar bone near the junction of its outer

The Brachial Artery.

and middle thirds (the coracoid process of the scapula), along the inner side of the arm to the middle of the front of the bend of the elbow.

Methods of Compression.

During the middle part of its course the artery can easily be compressed against the bone by grasping the arm and pressing outward with the fingers about half way between the front and the back of the limb. The thumb may be used to make counter-pressure upon the outer surface of the limb, or the thumb may be used to compress the artery and the fingers for counter-pressure (see Figs. 35 and 36). When compressing the artery near the elbow joint the pressure must be exerted backward and outward. The artery may also be controlled by the means described under hæmorrhage in general—*i. e.*, by a tourniquet or elastic constrictor. Pressure upon the main artery of the arm will stop bleeding from the forearm and hand.

Wounds of the large veins of the arm can be controlled by direct pressure with the finger or with a pad and bandage applied over the bleeding point.

The Axilla.

The axilla or armpit is a frequent site for boils and superficial abscesses. These often originate from want of cleanliness. The treatment is early incision and an antiseptic dressing. The arm should be kept in a sling.

Deep abscesses originating in the lymphatic glands of the axilla are of frequent occurrence. Infection usually takes place from an inflamed wound or abscess of the fingers, hand, or arm. Fever and prostration are often marked. If the pus is not allowed to escape freely death is not uncommon. The local symptoms of heat, redness, and swelling may be masked at first by the deep situation of the abscess, but tenderness and pain are always present to a marked degree and furnish a guide for the incision.

Tubercular inflammation of the lymphatic glands of the axilla occurs occasionally. The same painless, hard, slowly growing swellings are formed here as in the neck. The treatment is extirpation of the affected glands.

For diseases and injuries of the elbow, see *Joints*.

WOUNDS OF THE FOREARM.

Principal Arteries in the Forearm.

There are two principal arteries in the forearm. They are the end branches of the main artery of the arm, and are given off from that vessel just below the bend of the elbow. They pass down the front of the forearm, one on the outer, the other on the inner side of the limb. The pulsation of each can be felt just above the wrist, about three quarters of an inch from the outer and inner borders of the limb respectively. The outer one, the radial artery, is commonly utilized for counting the pulse.

Bleeding from these arteries may be fatal if uncontrolled. The means of stopping such bleeding are various. Pressure on the brachial artery with fingers or tourniquet is usually efficient. Extreme and forcible bending of the elbow joint and fixation in the bent position with a bandage may also be used. A pad in the bend of the elbow renders this treatment more effective. Direct finger pressure, or a tampon and a pad over the wound, will also accomplish the same result. It should be borne in mind that a simple inelastic cord or bandage tied about a limb above the bleeding point, without any pad to make direct pressure upon the main artery of the limb, is not a good means of controlling hæmorrhage. It is not easy to shut off the arterial circulation by this means. The veins are occluded while the blood is still passing through the arteries into the limb below the point of constriction. The limb becomes engorged with blood at once. The blood can not get back to the trunk through the veins, hence arterial bleeding continues, while bleeding from the veins is increased.

Hæmorrhage.

Caution.

Wounds of the forearm are often complicated by division of tendons which transmit motion to the wrist, hand, and fingers. The upper ends of the lower portions of the divided tendons can often be seen in the wound. They are white and glistening cords. Some of the motions of the hand and fingers are wanting or imperfectly performed. A surgeon should be seen in such cases at any cost. Failure to sew together the divided tendons will probably result in permanent disability. The large nerve trunks of the forearm are sometimes cut. There are three of them: one accompanies each artery, and the other lies alone along the middle of the front of the limb. Their division is followed by some loss of motion or of sensation, or both, in the hand and fingers. The cut ends should be sewed together, if possible, lest permanent paralysis result.

Division of Tendons and Nerve Trunks.

WOUNDS OF THE PALM.

Wounds of the palm may bleed profusely. The bleeding may be stopped by packing the wound with a tampon of gauze, and subsequent firm closure of the hand over some hard substance, such as a roller bandage, a stone or a piece of wood of suitable size. The fingers should be bandaged over the hard body in order to maintain pressure upon the wound. A handkerchief folded into a ribbon may be used for this purpose.

How to stop Hæmorrhage.

Division of tendons in the palm and back of the hand is followed by loss or impairment of motion in some of the fingers. It is very important that the ends of such tendons should be sewed together. The same is true of transverse wounds of both aspects of the fingers.

Inflamed wounds of the palm of the hand are serious from the danger of inflammation spreading to the sheaths of the tendons, and along these sheaths into the forearm. Large, deep abscesses are thus produced, and subsequent death of the tendons. The dangers of septicæmia are considerable in such cases, and the separation of the dead tendons takes place only after tedious suppuration. The functions of the hand are often greatly impaired. Such wounds should be subjected to the most thorough disinfection, and early, long, deep cuts should be made when necessary to provide for the escape of pus. The cuts should be in the long axis of the limb, so that no tendons are divided. Complete relief of all tension should be aimed at. When the pus has spread into the forearm, the inflamed tendon sheaths should be opened very freely. In severe cases it may be necessary to make an incision which begins in the middle of the palm and extends to the middle of the forearm, and such an incision will often save the patient the subsequent use of his hand and prevent weeks of pain and suppuration or death from septicæmia. In the writer's experience, a number of small cuts and the insertion of drainage-tubes do not answer as well as very free incisions in such cases.

Inflamed Wounds.

TENOSYNOVITIS CREPITANS.

As the result of prolonged and violent use of the hand and wrist, the tendon sheaths, most often on the back of the forearm, become inflamed. The inflammation does not lead to suppuration, but to a dry and roughened condition of the naturally smooth and moist sheaths in which the tendons play. Slight swelling is noticeable along the back of the forearm, and motion of the wrist and fingers is painful. If the palm of the hand be applied to the back of the patient's forearm while he makes active motions with his fingers, a peculiar creaking sensation is felt.

Recovery occurs in a few days under immobilization of the wrist and fingers on a palmar splint, counter-irritation over the tendons with iodine ointment, and pressure over the same with a firm pad and bandage.

GANGLION, VULGARLY "WEEPING SINEW."

A little elastic rounded lump appears suddenly or gradually, most often on the back of the wrist on a line with the index finger, evidently beneath the skin, to which it is not adherent. The disease is commonly a sacculated dilatation of the lining membrane of the wrist joint. The little swelling contains clear fluid. The communication with the joint may or may not be obliterated.

Ganglion sometimes causes a good deal of pain on motion of the wrist and considerable weakness of the hand. When this is the case it should be removed entire through a small cut in the skin. The wound heals

rapidly and the operation results in cure. It can be done painlessly with cocaine. Other forms of treatment are uncertain.

For fractures of the hand, see *Fractures*.

DISEASES OF THE HAND AND FINGERS.

Acute suppurative inflammation of the fingers may begin in the soft parts or in the bones. The bacteria ordinarily enter through a wound in the skin, often so minute as to escape observation. A ruptured blister, such as forms after unaccustomed pressure and friction, or a little tear in the skin at the side of the finger nail—a hangnail—are frequent ports of entry for the germs of inflammation. Occasionally, though rarely, the inflammation begins in the bone after a contusion, or in the course of multiple osteomyelitis.

Abscesses of the Fingers: Cause.

A common site for these abscesses is the ball of a finger. Owing to the abundant nerve supply and the dense, firm character of the tissues, the disease is very painful. The arrangement of the connective-tissue bundles in the pulp of the fingers is such that the pus tends rather to burrow deeply than to perforate the skin, and there is great danger of the inflammation spreading to the sheath of the flexor tendons of the finger, into the palm, and thence to the forearm. Unless treated energetically, other tendon sheaths may become involved, also the bones of the fingers. This is especially true of the bone of the last joint of the finger, owing to its close anatomical connection with the tendon which is attached to it. The tendons often die and separate slowly by suppuration. Invasion of the bone necessitates its removal or amputation. If the tendons are lost, the usefulness of the finger is, of course, greatly impaired.

Prognosis.

The smallest wound or abrasion of the fingers should be disinfected and covered with a film of cotton and flexible collodion, whenever this is practicable. When a superficial wound of a finger becomes red and tender it should be dressed with a wet antiseptic dressing of sugar-of-lead-and-alum solution or a solution of ichthyol. When the inflammation begins deeply and is attended by swelling and throbbing pain in the finger, with a point of extreme tenderness, it is unwise to wait for more decided evidences of the presence of pus. A small cut made at this time will save the patient from much suffering and from a very much larger cut, or from several large cuts, which would be necessary at a later period. Very early incision of these abscesses, followed by a wet antiseptic dressing, is often attended by a rapid disappearance of the inflammation and speedy healing of the wound with a small scar. Delay is usually disastrous, from causes already mentioned.

Treatment.

Under no conditions is the use of poultices followed by worse results

than in the treatment of these abscesses of the fingers. Extension of the inflammation to the tendon sheath is rendered almost certain, and the vitality of the tissues is so reduced that extensive sloughing or necrosis of the soft parts of the finger is a regular consequence. The writer has seen such a large number of fingers and even hands rendered almost useless by this form of treatment that he can not condemn it too strongly.

Erysipeloid.

Fish handlers, cooks, and occasionally others are subject to attacks of inflammation of the skin of the fingers and hands, characterized by intense redness, slight swelling, and moderate burning and itching of the affected skin. The borders of the inflammation are sharply marked, and the disease is peculiar in that it is apt to spread slowly or rapidly from one finger to another and on to the back of the hand. The parts first affected may get well while the inflammation is advancing elsewhere. The bacteria which produce the disease are found on crabs and other shellfish. The disease is not dangerous, and treatment with wet antiseptic dressings is followed by recovery in a few days.

"Runround."

Inflammation around the root of the finger nail—"runround," as it is called—is caused by infection with pus microbes. The disease often begins as a small abscess in the skin at one side of the nail, and the infection is prone to travel slowly along the base of the nail, causing it to become loose and act as a foreign body, thus prolonging the inflammation.

In mild cases a little cut to let out any pus which forms, and a wet antiseptic dressing, may suffice. In cases where the nail becomes loosened from its bed it is best to remove the entire nail at once and to scrape and disinfect the inflamed tissues thoroughly. Under less active treatment the inflammation is sometimes prolonged for months.

Dupuytren's Contraction of the Palmar Fascia.

A condensation and contraction of the subcutaneous fibrous tissue of the palm and palmar surface of the ring and little fingers occurs, the causes of which are not well understood. The disease runs a very chronic course and shows itself as a gradually increasing inability to straighten the fourth and fifth fingers; when of long duration, the fingers are markedly and permanently bent toward the palm. The operative division and removal of the contracted tissues is the only treatment. The results of such operations are good.

Warts.

Warts, which are true epithelial tumours of the skin, are common on the hand and fingers. They may be removed by destroying them with a drop of strong nitric acid. Care should be taken not to get any acid on the surrounding skin. When of large size, warts may be cut out bodily and the wound closed by a stitch.

CHAPTER XII.

THE LOWER EXTREMITY.

For injuries of the joints and fractures, see chapters on these topics.

Wounds; Arterial Bleeding.

The main artery and vein of the lower extremity pass from the middle of the front of the thigh at its junction with the trunk downward along the inner side of the limb to the middle of the ham or hollow at the back of the knee. The artery can be controlled temporarily by finger pressure as it passes over the brim of the pelvis into the thigh in the middle of the front of the limb. The position of the artery can usually be determined by its pulsation. Pressure must be made backward, so as to compress the vessel against the pelvic bone. Pretty firm pressure is required, and it is difficult for one person to keep it up for more than a few minutes uninterruptedly. The wounded person must lie upon his back. The one who controls the vessel stands or kneels beside him. The best place to apply a tourniquet to the thigh is at the middle of the limb. The pad which is to compress the vessel should be placed on the inner surface of the limb about half way between its anterior and posterior borders. The course of the femoral artery is indicated in Fig. 37.

Fig. 37.—Digital compression of the femoral artery.

The application of the elastic constrictor to the thigh has been described under the treatment of hæmorrhage. Its application at a high point will control arterial bleeding from the entire lower extremity.

Traumatic Aneurism.

Punctured wounds of the femoral artery are sometimes followed by the formation of a traumatic aneurism. This very serious condition is best relieved by ligature of the vessel above and below the wound, and extirpation of the aneurismal sac. The condition can be recognised by the formation of a pulsating tumour in the region of the wound. A whizzing sound can sometimes be heard, synchronous with the heart beat, by applying the ear to the swelling.

The same general rules of treatment apply to wounds of this as of other regions.

Tuberculosis of the Hip Joint; Symptoms.

Tuberculosis of the hip joint ("hip-joint disease"), beginning usually in the upper end of the thigh bone, is common among children. A recognition of the early signs of the disease is important. The first symptom is slight pain and stiffness of the joint on rising in the morning. Later a slight limp is noticed, and pain referred to the knee or hip. Gradually deformity develops. The thigh is bent upon the pelvis and the muscles become rigid and resist efforts to straighten the limb.

FIG. 38.—FLEXION OF THE THIGH UPON THE PELVIS, IN HIP-JOINT DISEASE.

This condition is best recognised by laying the child on its back naked upon a table, when it will be found that while the sound limb lies flat upon the table the other remains a little bent at the knee and raised from the surface upon which the body rests. If, now, the knee be pressed downward so that the back of the limb rests upon the table, no motion takes place at the hip joint. The lower part of the spine bends forward so that a hollow can be felt beneath the back, and the whole pelvis and thigh move together as though no joint existed at the hip. (See Figs. 38 and 39.)

When the child stands erect the weight of the body is supported by the sound limb; the affected thigh is held a little bent. Viewed from be-

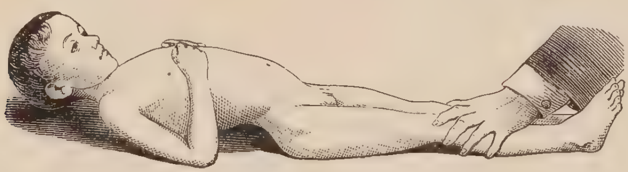


FIG. 39.—LORDOSIS, OR BENDING FORWARD OF THE SPINAL COLUMN, IN HIP-JOINT DISEASE.

hind, the furrow below the buttock is seen to be partly obliterated and to droop on the affected side (see Fig. 40.)

Outlook and Treatment.

As the disease progresses, the limb becomes more bent, rotated inward and shortened. The further destructive changes in the joint structures are similar to those already described under *Tuberculosis of Joints*. The treatment is also indicated in the same chapter.

The most important tumours which occur in the thigh are the malig-

nant sarcomata of the thigh bone. The disease often begins in the lower part of the femur and leads to enlargement of the bone of a rather rapidly progressive character. The treatment is amputation through the hip joint. The chances of cure are not good, but life may be considerably prolonged and rendered more comfortable. A few cases are cured.

Sarcomata of the Thigh Bone.

For injuries and inflammations of the knee joint, see chapter on *Joints*.

Bowlegs and knock-knee are deformities the appearances of which are familiar to every one. Both conditions are commonly associated with rickets. When present to a considerable degree treatment is necessary.

Bowlegs and Knock-knee.

In very young children treatment by apparatus of various kinds may be successful. The operative treatment consists in breaking the crooked bones with a mallet and chisel through a small cut in the skin, setting the fracture in a good position, and applying a fixed dressing of plaster of Paris. In some cases it is necessary to remove a small wedge of bone with its face directed toward the convex side of the curvature. The bones may also be broken without wounding the skin by means of an instrument known as an osteoclast. The results of all these operations are excellent.

FIG. 40.—FLEXION OF THE THIGH AND DROOPING OF THE FURROW BELOW THE BUTTOCK ON THE AFFECTED SIDE, IN HIP-JOINT DISEASE.

Persons whose occupation obliges them to kneel a good deal sometimes suffer from a chronic inflammation and enlargement of the little sac filled with watery fluid, which overlies and acts as a buffer for the knee cap. The enlargement may become excessive, and attacks of acute inflammation, and even of suppuration, may occur in and around the sac from time to time.

Housemaid's Knee.

The treatment consists in the operative removal of the sac. The operation is not dangerous, and results in cure.

Enlargement of the subcutaneous veins of the leg occurs usually in persons who have to stand erect during much of the time. The enlarged veins are increased in length as well as in diameter, and often form, when the individual stands erect, large, blue, tortuous, cordlike masses, extending from the ankle to the knee and sometimes to the groin. The subjective symptoms are a sense of fulness and pain in the leg, and sometimes severe cramps in the muscles. The changes produced in the nutrition of

Varicose Veins of the Leg: Symptoms.

the skin of the leg and foot by the sluggish circulation of the blood in the diseased veins are of more importance than the changes in the veins themselves. Slight sources of mechanical and chemical irritation, which, in a normal leg, would have merely a slight temporary effect, are not recovered from, and very commonly a chronic inflammation of the skin is induced, which becomes acute from trifling causes. This chronic *eczema of the leg*, as it is called, is one of the most troublesome conditions to treat successfully which a surgeon meets. The itching and burning in the skin of the leg which these patients suffer from is often intolerable.

Unless properly treated, a new and serious source of annoyance is added after a time. A trifling bruise, an abrasion of the skin, or a slight wound which in a healthy individual would amount to nothing, fails to heal, becomes inflamed, increases in size, and results in an intractable ulcer, which heals only after the most painstaking care, extending often over a period of many months. The ulceration is, of course, prone to recur upon slight provocation. Occasionally perforation of the wall of one of the dilated veins takes place, followed by violent bleeding, which may be dangerous if not controlled. The chronic ulcers sometimes become the seat of cancerous degeneration.

From infection with pus microbes attacks of inflammation may occur around the dilated veins, sometimes resulting in abscess; or the wall of the vein itself may be involved, and obliteration of the vein may take place as a consequence; or the infected clot which forms within the vein may soften and enter the general circulation, causing pyæmia.

Treatment.

The treatment of varicose veins of the leg is palliative and curative. The palliative treatment consists of measures intended to improve the circulation in the limb, and to prevent further increase in the size and number of the dilated veins. To this end the patient may wear a carefully applied roller bandage, extending from the bases of the toes to the knee. This should be worn constantly during the day and removed at night. Or, better, an elastic stocking, made to fit the limb of the individual, with a thin cotton stocking beneath it, next the skin. Pure rubber bandages, applied like a roller, are effective, but usually irritate the skin. The curative treatment consists in the operative removal of the enlarged veins. It is only applicable in a certain proportion of cases, and recurrences are not uncommon.

For the eczema a large number of local remedies are used in the form of lotions and ointments. During acute attacks of moist eczema, in which the skin is intensely red and covered with blisters which burst and discharge a large amount of watery fluid, rest in bed with the limb elevated, and the application of cloths kept wet with a three-per-cent. solution of ichthyol, is useful. When the acute symptoms subside somewhat, an ointment of zinc oxide (ten per cent.), containing salicylic acid

(two per cent.), applied freely to the limb and covered with gauze and a bandage, may be used.

Water should not be applied to the inflamed skin, nor should corrosive-sublimate solution be used to wash it. Before each dressing, the crusts which form, composed of dried discharges and dead skin, should be gently softened and removed with a cloth soaked in olive oil or liquid vaseline. When the inflammation of the skin is chronic, various stimulating ointments are used, such as diachylon ointment, or a ten-per-cent. ichthyol ointment containing one or two per cent. of tar.

The chronic ulcers demand very careful treatment, which can usually be carried out successfully only by a surgeon. They must be kept clean and dressed frequently. Various stimulating applications are applied to the raw surface, such as powdered naphthaline and Peruvian balsam. When the new tissue on the surface of an ulcer which is healing grows above the level of the surrounding skin, producing proud flesh, as it is called, it may be touched lightly with a stick of nitrate of silver. A firmly applied bandage must be worn throughout the treatment. These chronic ulcers sometimes become very large, and may completely surround the limb. In these cases excision of the ulcer and the application of skin grafts to the raw surface gives good results. Great care must be taken in the treatment of chronic ulcers to get the raw surface and the surrounding skin in an aseptic condition and to keep them so. To this end the same precautions are taken which were described in the treatment of wounds. Hands, dressings, and instruments must be scrupulously clean; the eczematous skin must, however, be protected as far as possible from contact with irritating antiseptics. Rest in bed and elevation of the limb often render possible the healing of an ulcer which could not otherwise be accomplished.

For injuries and diseases of the ankle joint, see chapter on *Joints*.

Flatfoot.

Flatfoot is a painful affection which depends upon a weakness of the structures which support the arch of the foot. The arch sinks in consequence, and the foot becomes flattened and displaced outward. It occurs usually in persons whose occupation requires them to spend much of their time standing.

The treatment consists in the introduction of a suitably arched steel spring into the sole of the shoe, thus furnishing an artificial support for the stretched and weakened ligaments and muscles. In extreme cases, associated with marked outward displacement of the whole foot, the deformity can sometimes be corrected by removing a wedge of bone from the inner side of the foot.

Bunion is a deformity of the great toe produced by wearing narrow-pointed shoes. The great toe is crowded outward; an angular displacement of the whole toe is gradually produced at the joint between the toe

Bunion.

and the foot proper. The tendons of the toe are displaced to the outer side, and the joint between the bone of the foot and the first bone of the great toe is seriously altered. The ends of the bones are enlarged and the ligaments of the joint are thickened. Over the projecting lower end of the bone of the foot there is often formed a little sac of fluid—a bursa—beneath the skin. From continued pressure, attacks of inflammation occur in the bursa which are very painful. Occasionally infection and suppuration with the formation of an abscess take place.

Treatment.

Prevention by the wearing of proper shoes is important. When the deformity is only slightly developed, a properly shaped shoe will usually be all the treatment necessary. Acute attacks of inflammation in the bursa may be treated by rest and wet dressings. If an abscess forms it should be opened. When the deformity is marked, the only satisfactory treatment consists in removing the enlarged lower end of the bone of the foot, followed by replacement of the toe in a straight position. The results of this operation are good. The various apparatus devised for the treatment of bunions are generally ineffective.

Ingrowing Toe Nail; Treatment.

Ingrowing toe nail is caused by wearing ill-fitting and tight shoes. The skin on one or both sides of the great toe nail is pressed against the sides of the nail until tenderness, inflammation, and ulceration of the compressed fold of skin are produced. The great toe nail should be trimmed straight across the end of the toe and not cut too short. The shoes should be wide enough to prevent the toes from being crowded together. When once developed, the most effective treatment is the operative removal of the skin at the side of the toe. This operation results in cure.

For chilblains, see *Frostbite.*

Clubfoot.

The deformities of the foot and ankle which have received the name of clubfoot are of several types, in the most common of which, known as *equino varus*, the front part of the foot droops. The sole of the foot looks inward, and the front part of the foot is rotated inward about a vertical axis, which passes through the smaller bones of the ankle. The patient walks upon the outer border of the foot, and in neglected cases upon what should be the upper surface of the foot, or instep.

Pes equinus, or horse foot, may exist alone, in which case the front part of the foot droops, the patient walks upon his toes, and in extreme cases upon the upper surface of the foot.

The opposite of *pes varus* is called *pes valgus.* In this case the sole of the foot looks outward and the patient walks upon the inner border of the foot.

In the deformity known as *pes calcaneus*, the opposite of *pes equinus*, the front part of the foot is drawn upward and the patient walks upon the heel.

There are several ways in which these different kinds of deformity may be combined. A large number of cases of clubfoot are congenital—*i. e.*, the children are born with one or more groups of muscles too short, so that the foot can not be brought into the natural position for walking. Other cases result from paralysis of certain groups of muscles due to disease of the spinal cord. Pes equinus, or drop foot, is often due to want of care in cases of long illness in bed, in which the patient's feet are allowed to fall downward from their own weight, as was mentioned in the treatment of fractures. Fractures and unreduced dislocations in the neighbourhood of the ankle joint may also result in one or other form of clubfoot.

Treatment.

The sooner children born with clubfeet are put under treatment the better. The treatment is mechanical and operative, usually a combination of both. The former method is suitable for cases of slight and moderate deformity. The child's foot is forcibly placed in better position and held there by some form of fixed apparatus, such as plaster of Paris. The apparatus is frequently removed, and active and passive movements are practised. A new apparatus with the foot in still better position is applied from time to time, until the deformity is completely overcome. In more severe cases this treatment is combined with cutting of the shortened tendons and other structures which maintain the malposition.

It is important that the deformity should be corrected before the child begins to walk, because if walking is commenced with the foot in a bad position the deformity will usually be increased thereby, and finally the bones of the foot and ankle will develop in an imperfect and deformed way, so that a cutting operation involving the removal of portions of the ankle bones will be necessary before the patient can tread properly upon the sole of the foot. The results of such operations, even in adults, are good.

CHAPTER XIII.

DEATH AND THE SIGNS OF DEATH.

Continuance of life depends chiefly upon the maintenance of the function of the lungs (breathing), of the function of the heart (the circulation of the blood), and of the functions of the brain. Cessation of breathing or of the circulation of the blood are speedily followed by death. When breathing is first affected, we speak of death from apnœa or from asphyxia; when the heart gives out first, we speak of death from syncope; when the functions of the brain are first paralyzed, we speak of death from coma. The activity of the brain may, however, be to a great extent in abeyance, and yet life may continue so long as those portions of the brain which control breathing and the action of the heart perform their functions.

Immediate Causes of Death.

When air is completely cut off from the lungs, as in drowning, asphyxia comes on in from one to two minutes, and the individual becomes unconscious. The heart continues to beat for a short time after breathing has ceased, and death occurs in from three to five minutes from the beginning of the process. There are some authentic cases in which, under unusual circumstances, life has been prolonged for a greater period, but such cases are exceptional.

The answer to the question, Is an individual really or only apparently dead? is rarely difficult. The more or less widespread dread of premature burial has little or no foundation in fact. The signs of death are as follows:

Signs of Death.

First, cessation of breathing. The movements of the chest and diaphragm during respiration are so evident that even a cursory examination could hardly fail to detect them. In any case, the application of the ear to the chest wall will demonstrate the presence or absence of the soft, blowing sound—the so-called *respiratory murmur*—which is produced by the air entering and leaving the lungs.

Second, the beating of the heart, which ceases a few seconds or even minutes after breathing has stopped, is not so evident to the untrained. In this case the absence of pulsation in the large arteries of the neck and at the wrist, and of the heart sounds, normally heard on applying the ear to the left side of the chest in front, are quite sufficient proof of death. There are a few cases on record in which breathing and respiration were carried on so faintly that an ordinary examination failed to detect their presence, but these have been extremely rare, and the recognition of the other signs of death which soon ensue would render the decision easy and positive after a short time in any instance.

Third, cooling of the body. After death the temperature of the body gradually falls until it becomes equal to that of the surrounding air. The rapidity of this change is modified by a number of circumstances—the temperature of the air, the size of the body, and the presence or absence of clothing or other covering. On the average, the temperature has been found by experiment to fall about 4° Fahr. for the first three hours after death, 3° per hour for the next six hours, and more than 1° per hour after that. In general, after ten or twelve hours the temperature of the body will have fallen to that of the surrounding air. After certain forms of death the cooling of the body is retarded. This is generally true of all forms of sudden death except drowning. In cases of death from chronic diseases cooling is rapid. The importance of this sign of death, however, rests more upon a gradual and continuous cooling of the body than upon any observed degree of temperature.

Immediately after death the eye loses its lustre. The cornea often becomes a little milky in appearance, and the eyeball loses its firmness and elasticity on pressure. There is also immediately after death an ashy pallor of the surface of the body and a general relaxation of the muscular system. The limbs can be moved in any direction easily. The lower jaw falls. The muscles still retain their irritability for some time, and will contract on the application of an electrical current.

Following the changes above described, and preceding decomposition, are certain physical alterations in the soft parts of the body which are important signs of death. The soft parts lose their elasticity so that they do not regain their shape after being pressed upon; thus the surface of the body retains the imprint of the irregularities of the surface upon which it has been lying, or, if the surface was smooth, the portions of the body which were resting upon it remain flattened.

Rigor Mortis.

Another still more characteristic sign is the so-called rigor mortis or stiffness of death. This change comes on in from eight to thirty hours after death—on the average, about twelve hours. Its duration is generally from twenty-four to thirty-six hours. It is due to a general hardening of the muscles such that the whole body becomes rigid. The joints can not be bent without considerable effort, but when once bent the limb remains flexible. The stiffness does not return. This positive sign may serve to distinguish real death from cases of so-called trance and catalepsy, in which latter condition the limbs can be moved in any direction without difficulty, but remain motionless for an indefinite period in any position in which they may be placed.

There are other signs of death of minor importance, but they are hardly necessary in order to arrive at a decision. For them the reader is referred to works on medical jurisprudence.

After a variable period, depending chiefly upon the relative degree of heat and moisture to which the body is exposed, the last series of changes occur, which, beginning with putrefaction, end in the complete decomposition of the organic or carbon-containing constituents of the organism. The end products consist chiefly of water, carbonic-acid gas, and ammonia. Numerous other products are formed during the process, some of which are gases possessing the characteristic odours of putrefaction.

Putrefaction.

In general, putrefaction begins soon after rigor mortis has disappeared. The signs are usually first seen on the lower part of the belly and groins, as a greenish-yellow discoloration of the skin. The superficial veins are often visible as brownish-red bands on the surface. The discoloration is next observed upon the face and neck, lastly upon the arms and legs. In cases of drowning, however, the discoloration usually first makes its appearance on the face and upper portion of the trunk. The formation of gases beneath the skin accompanies the discoloration and causes a rapidly increasing swelling which often reaches an extreme degree before the gases find an outlet. After a time the yellow and red discoloration of the surface changes to brown or black, and gradually all the soft tissues are converted into a semifluid, black mass.

When exposed to water or placed in a very damp soil, dead bodies occasionally become converted after some months into a fatty substance combined with ammonia, adipocere—in fact, into soap. This substance is white or yellow in colour. The form of the body is usually well preserved.

Adipocere.

Mummification consists of a rapid evaporation of the water contained in the body. It occurs when a dead body is exposed to dry air at a high temperature. The whole body is shrivelled and of a brown or yellow colour. The odour of putrefaction is absent.

Mummification.

CHAPTER XIV.

TRANSPORTATION OF THE INJURED.

When an individual is injured the problem of moving him to a place of safety comfortably, easily, speedily, and without further injury is often a difficult one to solve, and yet of great consequence. The temporary dressings and splints which may be applied to protect the injured part have already been described.

In the absence of an ambulance some form of stretcher upon which the patient lies at full length and is carried by two or four men, stationed one or two at either end of the apparatus, is the most convenient means of accomplishing this. Doors, window blinds, boards nailed together, mattresses, benches, tables, two saplings held twenty to twenty-four inches apart by cross-pieces at either end, upon which framework a blanket, a bedtick, or a piece of carpet may be sewed, nailed, or tied, may all be used for this purpose. During an Indian campaign it is said that General Jackson carried the wounded on litters made of the skin of oxen strung between two guns or poles. In the absence of a blanket or other cloth, withes or cords may be used to form the floor of the stretcher.

Improvising a Stretcher.

If a horse can be procured, two long poles or saplings may be used to form a travois or litter upon which the patient lies (see Fig. 41).

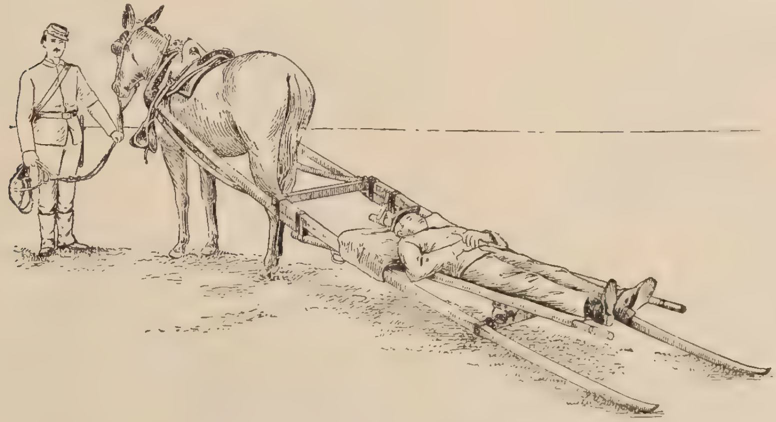


FIG. 41.—THE TRAVOIS.

The bearers of a litter should walk with short sliding steps. Except when the patient is in a condition of shock his head should be supported by a pillow. In wounds of the abdomen the patient should lie upon the injured side or upon his back with the knees bent and a pillow placed behind them to maintain this position. In injuries of the upper extremity the patient should lie upon his back with the limb resting at his side or across his body, or upon the sound side with the limb resting on the body. In wounds of the lower extremity the patient should lie upon his back. The litter should be kept horizontal in passing from one level to another. In general, the patient should be carried feet foremost, except when going up hill. In fractures of the lower extremity, however, the patient should be carried feet foremost when going up hill, head foremost when going down.

Carrying the Patient.

Fig. 42.—Patient across shoulder.

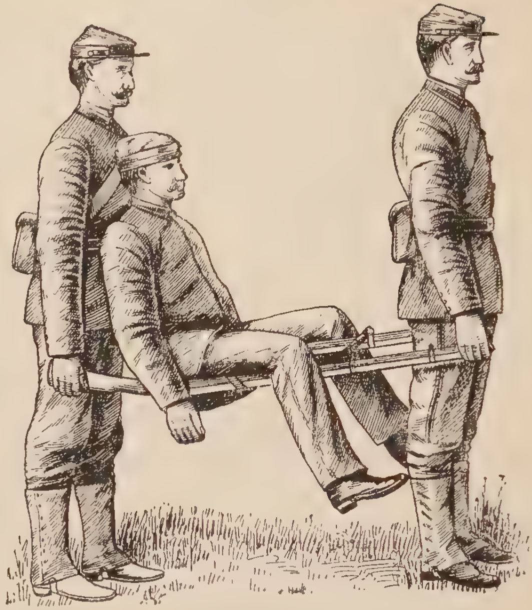


Fig. 44.—The rifle seat.

Fig. 43.—Patient across back.

Fig. 45.—Two-handed seat.

In placing a severely injured person upon a litter, two, or better three, persons should pass their arms beneath him, lifting and supporting the head and shoulders, trunk, and lower extremities, respectively. Figs. 42, 43, 44, and 45 illustrate several modes in which an injured person can be carried without a litter.

CHAPTER XV.

VENEREAL DISEASES.

There are three diseases which may be acquired through impure sexual contact: they are gonorrhœa, syphilis, and chancroid. Gonorrhœa is usually acquired from sexual contact, but there are numerous undoubted instances where individuals have taken the disease in other ways. Syphilis is usually acquired by sexual contact, but the number of cases in which the inoculation occurs in other ways is relatively very large. Chancroid is rarely acquired except by sexual contact.

GONORRHŒA.

Gonorrhœa is a purulent contagious inflammation of the mucous membrane of the genital tract, occasionally of the mucous membrane of the eye, rarely of the rectum, caused by a special microbe, the "gonococcus." The seat of the disease differs in the two sexes. In males, the inflammation affects the urethra primarily, but often extends later to other regions, which will be spoken of under complications.

Symptoms and Outlook.

The symptoms and course of the disease are as follows: From two to ten days after exposure the individual notices some swelling, redness, and itching of the orifice of the urethra, followed in a few hours by the appearance of a milky discharge. Urination is decidedly painful. After a day or two the discharge becomes abundant, thick, and creamy, and pain during urination intense. There may be fever and some prostration. The inflammation gradually travels backward, all the symptoms increasing in severity, until it reaches that portion of the canal which separates the front part of the urethra from the posterior part or neck of the bladder. This occurs usually after two weeks or more. In the minority of cases the disease extends no further. In the majority of cases the posterior portion of the canal (the neck of the bladder) also becomes involved. When this occurs new symptoms are added. The patient is obliged to urinate with great frequency, and the final closure of the neck of the bladder as the last drops of urine are expelled is attended by severe pain, sometimes by the passage of a few drops of blood.

When the front part of the canal alone is affected, the severity of the symptoms begins to abate after two or three weeks or more. The discharge becomes more watery, urination less painful, and after a very variable period recovery may take place; or, in many instances, all the acute symptoms disappear, but the inflammation persists as a chronic process in the deeper portion of the anterior urethra, constituting the disease known as *chronic gonorrhœa* or *gleet.*

In this condition the only symptoms may be a single drop of white or yellowish discharge which the patient notices in the orifice of the urethra upon rising in the morning; or this may be absent, and the only evidence of disease may be the presence of shreds of mucus and pus seen swimming in the urine when the patient empties his bladder into a glass vessel. The disease may persist in this form for months or for many years, and remain contagious to the end. The recognition and treatment of the chronic form of gonorrhœa in men is of great consequence, because persons so affected are the cause of untold suffering among many innocent wives.

The occurrence of such a chronic inflammation is favoured by want of treatment, by improper treatment, by indulgence in alcohol, by sexual indulgence, by a narrowing of the calibre of the urethra.

When the inflammation involves the neck of the bladder, it is more difficult to cure. It is very apt to become chronic, and to be attended by serious complications.

Complications.

The complications of gonorrhœa are very numerous. Among them may be mentioned inflammation of the epididymis, a portion of the testis. This condition, when it occurs in both testes, is often followed by permanent sterility—*i. e.*, inability to beget offspring; inflammation and sometimes abscess of the prostate gland which surrounds the deep urethra; inflammation of one or many joints throughout the body of an intractable character; inflammation of the tubes which carry the urine from the kidneys to the bladder; inflammation of the kidneys; pyæmia; septicæmia. Perhaps the most serious and fatal result of gonorrhœa in the male is the formation of scar tissue surrounding the urethra, resulting in a progressive narrowing of the calibre of the canal, producing what is known as *stricture of the urethra.* This condition follows the large proportion of cases.

Stricture.

Stricture following gonorrhœa may be limited to a single short section of the urethra, or there may be several narrowed portions, or the whole canal may be converted into a hard, unyielding tube of greatly diminished calibre. The symptoms produced by stricture are due to the obstacle which the narrowed portion of the canal presents to the free flow of urine. The individual most often presents himself for treatment on account of the persistence of a urethral

discharge which resists ordinary curative measures, or on account of a urethral discharge of a chronic character which has made its appearance years after the original infection, and has followed indulgence in coitus or alcohol.

If untreated, the strictured portion of the canal usually becomes gradually narrower, until finally there exists a well-marked mechanical obstacle to the flow of urine. The individual finds that it takes him longer to urinate than formerly, that the stream is not projected with the same force, and that he must strain somewhat to empty his bladder. At this period excess of any kind may be followed by an attack of what is known as retention of urine—*i. e.*, the individual finds himself with a full bladder and unable to empty it. Should he persist in his efforts, the thinned and dilated urethra behind the stricture may burst; the urine then escapes into the loose tissues of the parts, decomposes, produces a gangrenous inflammation and a rapidly fatal septicæmia, unless early relief by operation is afforded. Serious changes are also produced in the bladder by the mechanical obstruction to the flow of urine, and a narrow stricture of the urethra which exists for years untreated inevitably results in degenerative changes in the kidneys which not infrequently cause death.

Treatment of Gonorrhœa.

While the intelligent treatment of gonorrhœa in the male can be carried out only by a physician, some of the methods used may be mentioned here. The object of the treatment in acute cases is to destroy as soon as possible the microbes which are producing the inflammation. This can be accomplished in a fairly satisfactory manner in some cases by washing out the urethra at frequent intervals with a weak antiseptic solution. The most effective is, perhaps, a solution of corrosive sublimate, one part to 20,000 to 30,000 parts of water, according to the tolerance of the individual. Large quantities of a weak solution are better than smaller amounts of a stronger one, which is apt to produce an intensely painful and sensitive condition of the mucous membrane. Unfortunately, the gonococci soon multiply in the deeper layers of the mucous membrane, and we possess at present no antiseptic which can be used in sufficient strength to reach them in this situation without producing untoward results. When seen very early, gonorrhœa can sometimes be cured by the use of corrosive sublimate in ten days or a fortnight. In the majority of cases the disease lasts, under any form of treatment, for six weeks or more. Chronic gonorrhœa is best treated by the division with a knife of narrowed points in the canal, by the application of solutions of nitrate of silver to the inflamed portions of mucous membrane, and by the introduction into the urethra of steel instruments which dilate the canal.

Of the treatment of the complications of gonorrhœa we shall men-

tion only that of stricture. In a large proportion of cases this condition can be cured permanently by a cutting operation. In some cases the narrowed portions of the canal can be stretched gradually to a normal size by the introduction through them of smooth steel instruments known as sounds. Occasionally this treatment effects a cure. Generally, however, the sounds must be introduced from time to time throughout the patient's life.

No man who has had gonorrhœa should marry until he has been assured by a competent surgeon that he is free from contagion.

In the Female.

Gonorrhœa in the female affects the mucous membrane of the vulva, the urethra, the ducts of the glands of Bartholin—two glands as large as peas, which lie on either side of the entrance to the vagina. The process may be limited to these regions, in which case it is quite readily cured. In a large proportion of cases, however, the mucous membrane of the uterus becomes involved, and later on that of the Falloppian tubes, and finally there occur from time to time attacks of localized peritonitis. These serious conditions result generally in chronic invalidism and sterility, and often necessitate the operative removal of the diseased Falloppian tubes and of the ovaries as well, in order to relieve the individual from her constant suffering.

Many cases of gonorrhœa in women result from intercourse with husbands previously infected and never cured. The contagion is transmitted ignorantly doubtless, in most instances, but the results are none the less deplorable.

SYPHILIS.

Cause.

Syphilis is a contagious constitutional disease, usually acquired by sexual contact. Its cause has not been definitely determined, but syphilis presents so many points of analogy with tuberculosis, and other diseases the causes of which are known to be the presence and growth in the tissues of microbes, that we are justified in believing that syphilis also has a similar origin. Whatever the cause may be, the blood of a person with active syphilis, as well as the discharge from any sore existing during the active period of the disease, is contagious. A solution of continuity of the skin or mucous membrane, if only of microscopic size, is sufficient for the entrance of the poison into the system. After the inoculation is made the wound heals promptly and there is no evidence of any trouble for a period which varies from two to six weeks.

At the end of this period of incubation, as it is called, there forms at the site of the inoculation a lump or nodule, *the syphilitic chancre.* Its character varies somewhat according to the site of inoculation. In some situations the nodule is very hard, in others rather soft. In a majority

of the cases ulceration of the surface of the nodule takes place. The ulcerated surface resembles raw ham in colour, and discharges a little watery fluid which is often blood-stained. The chancre is neither painful nor tender unless irritated or inflamed by improper applications to its surface. Following the appearance of the chancre the neighbouring lymphatic glands become enlarged and hard. Such enlargements are usually painless, and but slightly tender. Two or three months after the appearance of the chancre the poison has reached the general circulation and disseminated itself throughout the body. Slight fever and *malaise* are not uncommon at this time.

Symptoms.

There now follow a series of characteristic eruptions upon the skin and mucous membrane of the mouth and throat. The skin eruptions vary a good deal in their character and date of appearance. In many cases the history of their occurrence is as follows: About six or eight weeks after infection, pinkish spots, not elevated, which almost fade when pressed upon with the finger, appear successively on the chest, abdomen, back, extremities, and face. The spots disappear in a few days or weeks and may give place to a general eruption of small, dull-red nodules, which have a light-brown colour when pressed upon; or, instead of these nodules, numerous pustules appear upon the skin, each one of which dries and becomes covered with a scab or crust. The spots, nodules, and pustules vary in size from a pinhead to a dime. The nodules and pustules usually last for several weeks or months and leave a light-brown stain behind. None of these lesions itch markedly nor are they painful. During the early months there may be falling out of the hair to a noticeable degree.

The eruptions upon the mucous membrane of the mouth and throat consist of shallow ulcers having a whitish centre and a red margin. They vary in size from a millet seed to a dime, or larger, and are often painful. The corners of the mouth and the tongue are a favourite site for these *mucous patches*, as they are called. It is from such lesions that syphilis may be communicated by kissing, and from the use of pipes, drinking vessels, dental instruments, and the like.

Following these early eruptions there occur a great variety of skin eruptions, for the character of which the reader is referred to works upon syphilis. In general they do not occur over the entire surface of the body, but are grouped together here and there.

After the first year of the disease the really serious and destructive lesions of syphilis may make their appearance. They are all characterized by the production of poorly organized new tissue, which resembles tubercle tissue in some respects, and, like tubercle tissue, is prone to undergo a form of degeneration which has received the special name "gummy," from the soft gummy mate-

Outlook.

rial which is the result of the process. This form of syphilitic inflammation may attack any organ in the body, and when the brain and spinal cord, or their covering, or any important part, become the seat of the process the results may be disastrous. Considerable loss of substance is sometimes the result of the degeneration of these gummy masses, and ugly deformities may be produced, of which the so-called syphilitic saddle nose is a familiar example.

Syphilis remains contagious for a period of several years. After four or five years a syphilitic individual who has been free from symptoms for two years or more may marry in safety, so far as the transmission of the disease to wife or offspring is concerned, but he can never be sure that the disease will not return in his own person, although these late manifestations are not contagious.

Treatment.

The essential part of the treatment of syphilis during the first year or eighteen months consists in the administration of one or other of the preparations of mercury, according to one of several plans. A constitutional effect should be produced which stops short of mercurial poisoning. During the later stages of the disease, iodide of potassium alone, or combined with mercury, is given in doses sufficient to relieve the symptoms.

Syphilis is one of the diseases for which we possess remedies of real value. Under suitable treatment the lesions of syphilis, in the majority of instances, fade away in a manner at once gratifying to patient and physician, although we do not know that the contagious stage is shortened thereby, nor can we ever be sure that the disease will not show itself again at a later period.

CHANCROID.

Chancroid is an acute contagious inflammatory disease acquired by inoculation with the discharge from another chancroid, and characterized by the formation of one or several pustules, which show a decided tendency to spread locally and to cause more or less extensive necrosis of tissue.

History and Outlook.

Chancroid is nearly always acquired during sexual intercourse. There is no distinct period of incubation. Within a day or two after exposure one or more red, tender, painful, elevated spots appear at the seat of inoculation; the centre of the elevation soon breaks down and leaves a craterlike ulcer, the base of which is covered with a yellow slough. The edges of the ulcer are undermined, red, and soft; the discharge of pus is abundant. If confined beneath a tight foreskin, untreated, improperly treated, or when occurring in individuals already broken down by dissipation and disease, the ulceration may progress rapidly and lead to extensive loss of tissue.

There are to be found in many hospitals neglected cases of chancroid which have existed for months and years. In a considerable proportion of cases inflammation and suppuration of the lymphatic glands of the groin take place, leading to the formation of abscesses which sometimes heal very slowly, or the wall of the abscess may ulcerate in a manner similar to the original chancroid.

Treatment.

Early destruction of the base of the ulcer with strong nitric acid or the actual cautery is the most certain treatment. If every portion of diseased tissue is destroyed the slough separates, leaving a healthy ulcer which heals rapidly under ordinary antiseptic dressings. The inflamed glands may be extirpated, or if an abscess has already formed it may be opened by a small puncture, washed out, and its cavity filled with a sterilized ten-per-cent. iodoform emulsion in glycerin or oil.

CHAPTER XVI.

DISEASES OF THE SKIN.

There are a very large number of diseases affecting the skin. In a considerable proportion of cases the nature of the affection is difficult to determine, and a certain diagnosis can be made only by an expert on this subject. There are a few skin diseases of common occurrence the recognition of which is comparatively easy. These alone will be mentioned in this chapter.

EXCESSIVE SWEATING.

Excessive sweating is a disorder of the sweat glands characterized by a local or general increase of perspiration. The palms of the hands, the soles of the feet, and the armpits are most apt to be affected in the localized form. The affection is usually chronic, and often difficult to cure. The general form is usually an accompaniment of debility. The localized form is often of nervous origin.

Treatment.

For the general form of the affection, mineral acids, tonics, and belladonna taken internally are sometimes effective. In the localized form, the application several times daily of a wash containing sulphate of zinc, alum, and tannin, in the strength of ten or fifteen grains of each to an ounce of water, is useful. Dusting powders must do good. They should be used freely. The following is a good formula: Salicylic acid, twenty grains; boric acid, two drachms; powdered starch, six drachms. Mix.

SEBORRHŒA.

Seborrhœa is an affection of the sebaceous glands characterized by the production of an increased amount of oily matter in the skin. The secretion of the glands may also be changed in character. The scalp and face are also usually affected. The skin is oily to an abnormal degree, or is covered with greasy crusts and scales (dandruff).

Treatment. Tonics when needed. Locally, in mild cases, Castile soap and hot water are useful. When crusts and scales are abundant, tincture of green soap may be substituted. The washing should be done often enough to keep the parts free from accumulated secretion. The following formula may be used on alternate days with the washing: Take of resorcin, one and a half drachm; castor oil, twenty drops; alcohol, four ounces. Mix. Rub into the scalp at night with a piece of flannel.

COMEDO (BLACKHEADS).

Comedo or blackheads, the appearance of which is familiar to every one, is a disorder of the sebaceous glands in which the secretion is retained and accumulated in the gland outlet. The accumulation of dirt gives the mass of sebaceous matter a black colour. The disease is often associated with constipation of the bowels and indigestion.

Treatment. Prolonged steaming of the face, tincture of green soap rubbed into the skin, and daily expression of the sebaceous plugs by pressure with the fingers or the barrel of a watch key are useful. Later the following lotion may be used to stimulate the glands to a healthy action: Take of sulphate of zinc and sulphuret of potassium, each one drachm; rose water, four ounces. Mix. Lotion for face. Should this application cause irritation of the skin, its use should be discontinued for a few days.

URTICARIA (HIVES OR NETTLERASH).

Urticaria is an affection of the skin characterized by the formation of white, pinkish, or reddish elevations or wheals, which vary greatly in size and shape. The lesions appear and disappear quite suddenly, and are as a rule attended by marked itching and burning. The disease is usually acute, lasting a few hours or days; rarely is it chronic. Disturbances of digestion from eating indigestible food or special kinds of food, such as strawberries and shellfish, are common causes; also certain drugs taken internally, and continuous external irritations, such as repeated bites of fleas and bedbugs.

When due to disturbance of digestion, a saline purgative may be given. Rhubarb and soda mixture may be given with advantage. Lo-

cally, a weak solution of carbolic acid, one to two teaspoonfuls to a pint of water, may be used; also, bathing in a solution of baking soda may be tried. The following lotion is useful: Take of carbolic acid one drachm; boric acid, four drachms; glycerin, one drachm; alcohol, two ounces; water, one pint. Mix. External use.

Treatment.

DERMATITIS (INFLAMMATION OF THE SKIN).

Dermatitis, or inflammation of the skin, caused by poison ivy, is characterized by redness and itching, sometimes by swelling and the formation of blisters. The eruption most often occurs on the hands and face. The inflammation may last from a week to six weeks.

Among the local applications used are a strong solution of boric acid (1 to 25), containing two drachms of carbolic acid to the pint; a solution of sulphate of zinc (one to four grains to the ounce); weak solutions of baking soda; ten-per-cent. zinc-oxide ointment; cold cream.

Treatment.

HERPES.

Herpes is a disease characterized by the formation of small, rather painful blisters on the skin. The blisters are situated on an inflamed base and often occur in groups. Usually but one or two such groups are present. The disease is often associated with fevers, and may occur as the result of indigestion. In many cases it appears to be a nervous affection. The face and genitals are the usual seats of the disease.

When situated upon the genitals, the application of camphorated cold cream is useful. Cleanliness, a dusting powder of calomel, and the application of the following lotion are good: Take of zinc oxide and calamine each five grains; of glycerin and alcohol, each six drops; water, one ounce. Mix.

Treatment.

HERPES ZOSTER (SHINGLES).

Herpes zoster, or shingles, is a nervous affection attended by pain and the formation of herpes blisters along the course of a cutaneous nerve. The nerves which run along the ribs are often affected. The pain usually begins before the appearance of the eruption, and may be severe.

A mild galvanic current applied daily over the affected nerve usually relieves the pain. The blisters may be covered with a film of collodion; if already broken, a ten-per-cent. ichthyol ointment spread on gauze and covered with a bandage is a good dressing.

PSORIASIS.

Psoriasis is a chronic inflammatory affection of the skin characterized by the formation of dry, red, rounded, sharply marked scaly patches upon the skin, usually a little elevated above the surface. The exterior surfaces of the extremities, especially of the elbows and knees, are common sites for the eruption. The scales are gray or silvery white in colour, and when scratched off leave a red, moist surface, which bleeds. The disease may last for an indefinite period. It is usually better in the summer months. Itching is absent or slight save in rare cases.

Treatment.

The scales should be removed with hot water and soap. The following solution, which forms a firm coating on the surface, may then be painted on the lesions: Take of chrysarobin one drachm; salicylic acid, twenty grains; ether, one drachm; castor oil, ten drops; collodion, seven drachms. Mix. The officinal tar ointment is also a useful application.

ECZEMA.

Eczema is an acute or chronic inflammation of the skin characterized by redness and itching, and sometimes by the formation of little inflammatory nodules in the skin or by the formation of blisters or pustules. In chronic cases the skin may be a good deal thickened. There are several distinct types of the disease, a detailed description of which must be sought for in works on diseases of the skin. In general, it may be said that the inflamed skin is either dry and scaly or moist. The discharge from the moist form dries upon the skin, forming crusts. All the forms of eczema, if untreated, tend to become chronic. Eczema may occur upon any portion of the body. Favourite sites are the scalp and face and the flexor surfaces of the extremities. In some individuals there is a constitutional predisposition to eczema, which is sometimes associated with gout. Any source of external irritation may produce the disease.

Treatment.

In many cases a carefully regulated diet and mode of life must be followed in order to obtain a cure. Tonics, alkalies, diuretics, laxatives, and antirheumatic remedies are of use in certain cases. The general treatment requires intelligent medical supervision. The local treatment has been mentioned under the treatment of varicose veins of the leg.

ACNE.

Acne is an inflammatory disease of the sebaceous glands characterized by the formation of little inflamed lumps on the skin, which sometimes form minute abscesses. The face and back are favourite sites for the eruption. The individual lesions last a few days and disappear, some-

times leaving a scar. The disease tends to continue indefinitely, one crop of lesions being succeeded by others. The lesions may be few or many in number. The disease sometimes disappears spontaneously during the third decade of life.

Treatment. Tonics and laxatives should be given when needed. The local treatment consists of incision of the individual acne pustules with a small knife and the subsequent expression of their contents, and of the use of stimulating applications, among which is the tincture of green soap, to be applied daily. Should this solution prove too irritating, lead-and-opium wash may be substituted. The disease is essentially chronic, and treatment usually must be extended over months or years.

RINGWORM OR TINEA.

Ringworm or tinea is caused by a fungus growing upon the skin and characterized by round or oval, red or reddish-brown, slightly elevated, scaly patches, and attended by moderate itching. The disease is contagious, and may be communicated from one individual to another by contact, or the lesions may multiply themselves upon the same individual. The sharply marked border of the lesions, their rounded form, the fine branny scales which cover them, and a tendency to heal in the centre while advancing at the edges render the diagnosis easy. When the disease occurs upon the scalp the roots of the hairs are affected and a small bald spot may be produced.

Treatment. One or more applications of strong tincture of iodine to the diseased surface is usually sufficient to effect a cure. On the scalp and the bearded portion of the face the hairs affected should be pulled out, and an ointment composed of lard containing five or ten per cent. of salicylic acid or one half of one per cent. of corrosive sublimate may be rubbed into the affected area.

SCABIES (THE ITCH).

The itch is a contagious inflammatory disease of the skin caused by an animal parasite, the itch mite, which burrows beneath the superficial layers of the skin. The lesions produced vary somewhat during the different stages of the disease. The soft skin between the fingers is usually first affected. As the itch mite advances his trail is marked by a minute, elongated blister containing watery fluid, eggs, and the excrement of the animal. The itch mite is situated at the further end of the blister. Each little burrow lies upon an inflamed base. The burrows themselves are easily recognised with the naked eye, the itch mite only with the aid of a magnifying glass. The blisters are soon ruptured by scratching, and the finger nails carry the eggs to the accessible portions of the body,

where they hatch out and in their turn produce new burrows. The parts secondarily affected are usually the inner surfaces of the thighs, the genitals, the abdomen, armpits, the flexor surfaces of the forearms, and, in women, the lower surface of the breasts. As the result of continued scratching, the original character of the lesions is obscured. The affected skin is covered by long abrasions produced by the finger nails, and in many cases a pustular eruption caused by infection with pus microbes is added. Unless seen in its early stages, the disease must often be recognised by these secondary characters.

Treatment.

The treatment consists of a bath of hot water and soap, followed by the application of an ointment which destroys the parasites and their eggs. Take of sulphur one ounce; of balsam of Peru, half an ounce; of β naphthol, two drachms; of lard and of vaseline, equal parts, as much as may be sufficient to make four ounces of ointment. Mix for external use. The application of the ointment should be repeated on several successive days, and this treatment followed by a hot soap-and-water bath.

HEAD LICE.

The presence of head lice may be recognised by itching of the scalp and by the formation of various inflammatory lesions upon the skin of the head and neck, and by finding the lice themselves and their eggs. The latter are minute gray or grayish-white, pear-shaped bodies, visible to the naked eye, and fastened upon the shaft of the hairs with the small end toward the root. The secondary inflammatory lesions produced by scratching are often prominent symptoms for which the patients present themselves for treatment. Swelling and even suppuration of the lymphatic glands of the neck sometimes occurs as the results of infected scratch abrasions. Stiffness of the muscles of one or both sides of the neck, simulating spasmodic wryneck or disease of cervical vertebræ respectively, is not infrequently present.

Treatment.

The thorough application to the hair of a mixture composed of equal parts of petroleum oil and olive oil, repeated nightly for three nights, followed by thorough scrubbing with soap and water, is usually effective. The head of the individual should be protected by a towel after the application. Approach to gas or other flame should be carefully avoided. More rapidly effective is the application to the hair of a mixture composed of equal parts of ether and tincture of larkspur. After this application approach to a flame should be avoided with the greatest care, for the vapour given off by the ether may catch fire even at a distance of several feet, and cause terrible burns. It is best in many cases to cut the hair short.

BODY LICE.

The body louse, larger than the head louse, inhabits the clothing, and makes excursions upon the body for food. The bites occur especially upon those regions where the clothing fits tightly—about the waist and on the upper part of the chest. The bodies of those individuals long afflicted with these parasites acquire a characteristic appearance. The continued scratching leads to the development of a deep-brown pigmentation of the skin of the abdomen and thighs. The body is also covered with recent scratch marks. A bath of hot water and soap, with disinfection of the clothing by boiling or baking, is all that is necessary.

CRAB LICE.

The smallest of the three varieties inhabits chiefly the skin of the genitals, occasionally the armpits, the eyebrows, and the margins of the eyelids. The parasite, which resembles a crab somewhat in appearance, clings closely to the skin by means of its powerful hooked claws. It is found, upon close examination, at the roots of the hairs as a minute brownish spot, scarcely elevated above the surrounding skin, and removed only with difficulty. A variable amount of itching is produced, which may be scarcely noticeable or severe.

The local application at night of half a teaspoonful of mercurial ointment to the affected region, followed by a soap-and water bath in the morning, the application to be repeated once or twice, if necessary, is efficient. A watery lotion of corrosive sublimate, two or three grains to the ounce, answers the same purpose.

CONCLUSION.

In concluding this article the writer wishes to emphasize the fact that *in the treatment of many surgical diseases and injuries delay often entails increased suffering, a graver risk, and, in many instances, loss of life.* He can think of no more fitting way in which to bring his article to a close than by adding a few examples tending to show that his admonitions on this head are necessary.

Many will doubtless be surprised to learn that a fresh wound, a fracture, or a dislocation often demands relatively less haste in procuring surgical aid than do abscesses and other purulent inflammations, tumours, tubercular inflammations, and even certain deformities. Yet such may fairly be stated to be the case. An open wound, if there be no serious bleeding, is much more likely to heal without inflammation if left alone, even for days, than if covered with an unclean dressing applied simply for the sake of doing something. A broken bone can often be

put in place as well at the end of five days or a week as immediately after the accident. The majority of dislocations can be reduced as readily after several days as immediately after their occurrence.

On the other hand, every hour of delay in opening an acute abscess causes increased suffering, destruction of tissue, and more marked constitutional poisoning. Every week which elapses renders it more difficult to remove thoroughly a cancer of the breast and diminishes the chances of permanent cure. Every month during which a child with hip-joint or spinal disease is allowed to go about untreated diminishes its chances of recovery.

That these remarks are not unnecessary a visit to the wards of any hospital will furnish abundant proof. Only too often the surgeon must undertake his operations with misgivings or with only the hope of temporary benefit, sadly thinking to himself: "If this patient had but come for treatment months ago how much better his chances would have been!" And sometimes he is forced to say, when disease which might have been cured at an earlier period has advanced beyond the reach of surgical aid: "No, I would not advise you to have any operation done. I will give you some medicine which will diminish your pain and make you more comfortable."

VII.

DISEASES IN GENERAL.

By J. WEST ROOSEVELT, M. D., and
WILLIAM P. NORTHRUP, M. D.

CHAPTER I.

THE CAUSES OF DISEASE.

Unhealthful Surroundings.

Unhealthful surroundings are a frequent cause of disease. The danger to health from bad air, bad water, and unsanitary dwelling houses is fully set forth in the article on *Hygiene*, and needs only to be mentioned now in order to call the reader's attention to its reality. There are, however, certain causes of much suffering and sickness which ought to be classed among these "unhealthful surroundings," but which rarely are so classed, and indeed are rarely mentioned by writers save in a very vague way. It is important to bear in mind that perfectly healthy people, and people suffering from non-contagious ailments, may be the cause of ill health among some with whom they are thrown in close relations. The selfish, the ill-tempered, the quarrelsome, the perverse, the whining, the nagging, the overbearing, be it man or woman, always makes the lives about him or her more or less unhappy, and unhappiness, if sufficiently great and sufficiently prolonged, may make a weak body into a sick body. The fact that human pests of the kinds mentioned usually contrive to worry their victims makes the unhappiness produced by them particularly injurious to health. *Worry is probably the most harmful mental strain to which human beings can be subjected.* It has been said that mental work never causes the health to break down, but that *worry* often does, and that sickness which is said to result from *overwork* is really due entirely to *overworry*. This statement is rather too sweeping, for it is hardly correct to deny the possibility of injury from overwork; but there is no doubt that worry alone ruins the health of many more people than does work alone, and that it does so most frequently in cases of the weary or disheartened. Persons who by their selfishness or inconsiderateness cause worry to others must not be regarded merely as intensely disagreeable companions — they must be

looked upon as more or less dangerous to the health of their neighbours, as part of the "unhealthful surroundings," which, if possible, should be got rid of. As one gets rid of bad plumbing either by repairing it, so as to keep the noxious gases from escaping, or by removing it entirely, so ought these objectionable people to be dealt with by the sanitarian, either in some way whereby they are stopped from poisoning those around them, or by removing them to some place where they can do no more harm. Unfortunately, it is rarely possible to do either of these things, and so the health of the worthier and better must often suffer.

Improper Food.

The use of indigestible food, whether this be indigestible in its original form or become so from bad cooking, is a well-recognised cause of dyspepsia of various sorts. In the matter of food we must remember that the adage is literally true—"What is one man's meat is another man's poison." There is probably no single article of diet, no matter how wholesome and digestible it is found to be by the vast majority of mankind, which is not in some case extremely indigestible, or even poisonous. The following examples occur to my mind in which I have personally observed in different cases more or less poisonous qualities of a number of articles of food, which are for most people very easy to digest: Roast mutton, roast veal, fresh shellfish and other fish, strawberries, apples, peaches, bread, potatoes, eggs, milk. I have seen people in whom half a wineglass of sherry or a few swallows of beer gave rise to very severe indigestion. One man of my acquaintance is prostrated with intense stomach ache and marked diarrhœa by a teaspoonful of Tarragon vinegar, and in this same man five grains of quinine causes violent colic. There are, on the other hand, some people who find many things which are positively injurious to the majority of mankind not only harmless to themselves, but even positively beneficial. While there is no absolute rule, applicable in all cases, whereby we can say what we may eat or drink without ascertaining by actual experiment, there are certain facts ascertained by wide observation which enable us to say what kinds of food are *likely* to be wholesome and what harmful for a person living under given conditions. It is not to be supposed that a proper diet can be selected for anyone if attention be directed *only to the human being without regard to his occupation and surroundings.* A diet which conduces to perfect health in a scholar of sedentary habits, whose utmost physical effort is limited to a short daily walk, would probably reduce a blacksmith nearly to starvation, and the blacksmith's ordinary dinner might be so great in quantity and so coarse in quality as to meet the scholar's needs, if bulk alone be considered, for two days, while its quality may be such as to make it not much more nourishing than an equal bulk of cobblestones. It is in general true that a sedentary man requires and can digest less food than an active one, yet

there are quite numerous instances in which the converse is true. Some professional men of sedentary habits have enormous appetites, and some athletes eat very little. Moreover, the quantity of food taken seems to have no relation to the stoutness or leanness of either sedentary or athlete; a man may eat but little, exercise a good deal, and yet be stout, and a large eater, who takes little or no exercise, may be very thin, and yet both may be in good health. There are as great differences between human engines in respect to their effective use of the food consumed as between steam engines in respect to the power developed from a given weight of coal burned; some engines, human or steam, waste more, and others less, of the energy contained in fuel. The same food, in the same amount, which in one climate is found by experience to agree perfectly with a man, may in another climate prove most injurious to health. The robust, sturdy Englishman who tries in India to eat and drink as had been his custom for years in England, finds that the attempt very frequently results in ill health, or perhaps in death.

Overeating.

Quite as important as the sort of food is the quantity eaten. An old friend of mine, who was a keen observer, used to say that "more people die of overeating than of overdrinking." There is some truth in the remark. If by "overeating" is meant not only swallowing too great a quantity of food, but also swallowing improper food, those who eat to excess far exceed in numbers those who drink to excess. An overworked digestive system is always a menace to health, and overeating may and often does cause disease of the stomach and intestines, liver, kidneys, or heart. It is particularly apt to do mischief in gouty people, either bringing on attacks of acute gout itself or doing harm to some of the organs mentioned.

Stimulants and Narcotics; Alcohol.

The injurious effects of alcohol have been too often and too fully discussed to make necessary more than a brief allusion to the use of this powerful drug. It is sufficient to say that *alcohol in any form, if taken to excess, is a frequent cause of disease and death;* that it is very doubtful if in the United States it is ever really beneficial for young people to use habitually any alcoholic drink of any sort; that while beer and light wines are the least harmful alcoholic drinks to most persons, to others they are very injurious; and that there is no question that in hot weather alcohol is more or less dangerous, no matter whether it be taken in beer, wine, or distilled liquor.

Of course, no definition of the word "excess" can be framed which indicates the precise amount of the stimulant which is injurious; individual susceptibility varies too greatly, and what is excess in one is extreme moderation in another. It is as impossible to draw a line between drunkenness and sobriety as it is to do so between sanity and insanity.

Maudlin drunkenness and raving mania are easy to recognise, but slight intoxication and slight insanity are alike impossible to separate sharply from perfectly normal mental states. Drunkenness is undoubtedly proof of "excess." It is a matter to be decided by the individual whether or not he "feels" the liquor. If he does he has had an excessive quantity; but it must be remembered that one may be unconscious of anything like intoxication and yet be decidedly drunk. If after a number of hours headache or stomach symptoms develop, these are proofs of excess.

Tea and Coffee.

Both tea and coffee are causes of nervous disorders and of various sorts of diseases of the stomach and intestines—tea more often than coffee, possibly because it is more generally used in excessive quantities, but probably because it is in itself more injurious on account of the large amount of tannin contained in the infusion when strong.

Tobacco.

Tobacco may, like tea and coffee, cause nervous and digestive disorders. It is also a cause of disease of the air-passages. It is said sometimes to cause absolute blindness; but there is some question whether this last symptom follows the use of tobacco alone, or whether alcohol is not always necessary, in addition to it, to affect the optic nerve. The blindness may be a result of alcohol rather than tobacco poisoning.

Other Stimulants and Narcotics.

Opium, morphine, chloral, ether, chloroform, cocaine, antipyrine, and a number of other stimulants or narcotics are all, when habitually used, apt to destroy the health.

*Injurious Habits.**

It is a rule that human beings are better in health when regular in their hours for sleep, eating, work, and play, than when this is not the case. Perfect health usually demands a fixed amount of sleep, and Nature can generally be trusted (*provided the hour for retiring is fixed, and provided one does not learn to indulge in the sensual enjoyment of drowsing after first awaking*) to indicate the amount required by waking the sleeper in a refreshed condition. If one watches a young, healthy child go to sleep and wake up, one sees that the period of sleepiness is very suddenly followed by deep, quiet sleep, and that the awakening, unless artificially induced, is quite sudden, although the little one is apt to show some inclination to continue its unconsciousness. When, however, the child has once really become thoroughly awake, it is evidently refreshed and cheerful, and a healthy adult after sufficient sleep should have the same pleasant sensations as soon as the sleep is

* The word "habits" as here used is almost synonymous with "customs." I do not intend it to be understood as meaning what it does in the terms "opium habit," "alcohol habit," etc. I use it in the sense which it expresses in the phrases "neat in his habits," "regular in his habits," "methodical habits."

ended. It is true that almost every one who is unconscious, whether from sleep or disease, seems to have a decided desire to remain so, and instinctively tries to put off the time when he must return to active life; therefore the first wish of the awakening sleeper is to sleep more, but in health this wish does not last long, and gives way to a sense of energetic content. The habit of overeating has been mentioned; the habit of eating too fast is another injurious to health. The habit of worrying is dangerous, a fact already pointed out. In the matter of habits it may be said that all are more or less injurious which do not conform to the general rule that the body tends to accommodate itself to a certain rhythm, doubtless imposed upon it by its adaptation to the rhythmical sequence of day and night, and that the body is pretty apt to indicate what are injurious if one carefully and fairly questions it. If a certain course of action is repeated a number of times, and is always followed by discomfort, it means that such a course is harmful, provided the health before adopting it was good.

Lack of Exercise.

Among the disease-causing habits is to be reckoned lack of exercise. If the body be not made to do a certain amount of physical work it is apt to degenerate. The old adage, "If a man will not work, neither shall he eat," is true in other than its literal sense. If he does no physical work he often can not eat, having no appetite. More often, although he can and does eat, he fails to digest the food eaten, or, at least, fails to assimilate it properly. One of the results of exercise is that by it the circulation is quickened and all the organs get more nourishment than they previously had; hence all the functions are performed more perfectly. The more rapid circulation not only carries nutritive materials in greater abundance to the entire body, it also removes waste products more fully and more rapidly; and these waste products are always deleterious when present in large amounts. (See *Physiology: The Vital Processes in Health.*) Moreover, the mere using the body machinery, unless carried to the point of exhaustion, tends to strengthen the parts used, while prolonged disuse weakens them.

The man who, without taking exercise, manages to eat largely is doing much the same thing as would an engineer if he continued to keep the fire under the boiler of an engine which is running at low speed as hot as would be required to produce high speed. This would soon develop a dangerously high pressure in the boiler and would endanger the machinery. So does too much food endanger the machinery of a sedentary man, by accumulating too much energy in the organs, just as the excessive consumption of fuel accumulates too much energy in the boiler, with resulting strain and injury.

There are a number of occupations which are causes of disease. For the most part these are harmful because they involve contact with poison-

ous substances (such as lead, arsenic, etc.), or the inhalation of gaseous fumes or gases (such as are produced in certain processes of the manufacture of various chemical compounds), or the exposure of the body to abnormal conditions of temperature (stokers in hot fire-rooms), or air pressure (divers in armour, and workmen in the caissons or submarine structures, used in building the piers of bridges, etc.), or the inhalation of particles of dust (knife grinders, coal miners). In addition to such as are harmful because of the nature of the materials used or of the abnormal temperature or air pressure involved in their pursuit, some occupations cause ill health by mere mental or bodily wear and tear. The nervous system sometimes gives out under long-continued strain (business anxieties and responsibilities, etc.), or when certain muscles are employed in executing some delicate task for a long time (writer's cramp, etc.), or when the occupation is very monotonous and exacting and the worker is of a nervous temperament.

Injurious Occupations.

It is the fashion to lay great stress upon the influence of heredity as determining all sorts of phenomena observed in living organisms. It is a little strange, therefore, to note the strong tendency among scientific medical men to deny its importance as a cause of many diseases which a few years ago were thought to depend largely upon its influence. That certain diseases may be transmitted from generation to generation can not be doubted. Insanity and gout are examples of disorders which are often thus transmitted. It is proven that certain forms of cancer also are apt to appear among the descendants of people suffering from these forms. Syphilis unquestionably is transmitted directly to many of the children of parents suffering from this disease in an active stage.

Heredity and Hereditary Disease.

In the cases last mentioned the parent infects the embryo, and the child is born with the poison of syphilis actually present as such in its body. In the other cases the descendants are not often born with the real seeds (if I may so express it) within them. The syphilitic child is born syphilitic, but neither gout, nor cancer, nor insanity are apt to be manifested in very early life. What is inherited is a body susceptible to the *influences* which cause rheumatism or gout, or perhaps certain organs inherently weak, so that after a time they fail to do their work properly, and, instead of producing such changes in the food as result in the most perfect possible combustion of it, and removal of the ashes in the form of waste, merely partially burn it and make poisonous substances, to the injury of the body. Thus, according to one theory, gout is the result of an inherited weakness of the liver, which makes that organ unable to complete the requisite changes in the nitrogenous substances derived from meat, eggs, etc., so that they finally are discharged

from the body in the form of carbonic acid, water, and urea. (See *Physiology: The Vital Processes in Health.*) Urea is the ash of such substances. Instead of oxidizing them completely, the liver converts a large part of them into uric acid, which is an injurious compound if present in too large amounts, and which is deposited as urate of soda in the joints during an acute attack of gout, and gives rise to many serious symptoms and even leads to grave disease of various organs in some people who never have an acute outbreak. See *Gout.*

The question of heredity in tuberculosis will be more fully considered under the various sections which describe the local manifestations of that disorder. (See *Diseases of Digestive Organs, Heart, and Lungs.*) For the present it suffices to say that *tubercle bacilli* are not transmitted directly from parent to child, but it is possible that bodily peculiarities of structure are transmitted which make the children of the tuberculous unable to withstand the onset of the germs. They furnish a *good soil* for the growth of the bacilli in organs which owe their weakness to heredity, but they can not be said to inherit tuberculosis in the sense that syphilis is inherited: they are not born with the disease germs already in their bodies.

CHAPTER II.

INFECTION AND INFECTIOUS DISEASES.

Infection Defined.

INFECTION means the entrance into the body of some poison which produces disease. The term is applied only to cases in which the poison causes what we ordinarily understand by the word "disease"; for example, we do not speak of "infection with lead" or "infection with morphine"—we speak of lead or morphine "poisoning." On the other hand, we speak of "infection with scarlet fever," or tuberculosis, or malaria, etc., and we call diseases caused by infection "infectious diseases."

Much misunderstanding exists as to the meaning of the terms *infectious* and *contagious* when applied to disease. It is therefore best to define them. The following definitions are taken from Foster's *Encyclopædic Medical Dictionary:*

INFECTION.—The act or process by which disease is set up in an organism by the implantation of morbific germs from without, or of a part of the organism by the conveyance of such germs from another part. Infection differs from contagion in the fact that the germs are not necessarily transferred from another organism. . . .

Contagious diseases, then, are necessarily *infectious*, since they are due to *infections*, but *infectious diseases* are not necessarily *contagious*. There is some practical advantage in making the following classification:

Classification.

THE INFECTIOUS DISEASES INCLUDE—

Class I. NON-CONTAGIOUS DISEASES, such as malarial fever, cerebrospinal fever, etc.

Class II. CONTAGIOUS DISEASES, such as scarlet fever, smallpox, etc.

Class III. COMMUNICABLE DISEASES, such as syphilis, tuberculosis, typhoid fever, etc.

Non contagious infectious diseases can not be transmitted, directly or indirectly, from the sick to the well. A patient with chills and fever is not dangerous to his neighbours; they can not "catch" the disease from him. Malarial poisoning can only result from residence in a *region of country in which the malarial germs find conditions favourable to their existence and propagation.* Human beings become infected from the germs growing in a neighbourhood, not from those inhabiting the bodies of other human beings.

Non-contagious Diseases.

In *contagious* infectious diseases the infection takes place by poison which is given off from the bodies of the sick in a form which in some way is carried through the air, and, entering the bodies of healthy people who are near enough to the patient, produces in susceptible subjects the disease from which the patient suffers. Thus smallpox and scarlet fever spread, the sick infecting the well through the air. In many diseases of this class (and especially in scarlet fever, smallpox, and diphtheria *) the poison

Contagious Diseases.

* I prefer for practical reasons to class diphtheria as a *contagious* rather than a *communicable* disease. While it is true that could we be sure of destroying every particle of the expectoration, nasal mucus, and all discharges of every sort from the body of a diphtheritic patient, we should surely prevent the infection of others; we *can not be sure* of doing this, and, moreover, the chances in the case of an unruly child or stupid adult of accomplishing the feat of catching and destroying all the material coughed up are so slight that common sense compels us to avoid exposing others to danger from particles which may have escaped our notice. *Theoretically* it is right to call diphtheria *communicable* and not *contagious*, for we know that the poison does not spread as does that of smallpox, measles, or other true contagious disease, through the air directly from person to person in an unknown way; it is carried by discharges which are liquid. *Practically*, however, since the bacilli live after these discharges have become dry, and since excessively minute quantities of the discharges are capable of producing malignant disease in the healthy, and, moreover, since the violent coughing and struggling of the patients make it very difficult, if not indeed impossible, to collect and disinfect all the expectoration, we must look upon the disease as almost if not quite as dangerous as a true contagious one, and act accordingly. Disinfect by all means, and disinfect thoroughly, for by so doing we diminish the danger many times: but beware of trusting entirely to disinfec-

may be indirectly communicated through the medium of toys, clothing, furniture, books, or papers which have been in the room with the patient, or have been used by him while sick. Thus smallpox has been caught from the clothing worn by smallpox patients, from carriages in which they have been transported, from the furniture of their rooms, and from the walls or floor of the rooms themselves. Scarlet fever has been spread to uninfected places by clothing, books, and, in one instance at least, by a picture which had hung in the room of a patient, and which was taken down, rolled, and sent a considerable distance by mail, to cause an epidemic in the village where it was unrolled. The poison of diphtheria clings tenaciously for a long time (months and perhaps even years) to many inanimate objects. When not thoroughly disinfected the room used by a diphtheritic becomes a hotbed of infection. Many and many a case has arisen from keeping the favourite toy of some beloved child who has died of the disease. Sentiment is a praiseworthy emotion in general, but to preserve a death-dealing object for sentimental reasons, while not criminal, is not criminal only because of the omission of law-givers to make it so. It is as wicked as any conceivable act of criminal negligence, and one who keeps such mementoes (and many are the people who do) as toys, or clothing, or ornaments, or locks of hair which have been exposed to contagion, *unless these have been submitted to a process of disinfection of a sort which has been beyond all shadow of doubt effectual*, is morally guilty of manslaughter if a fatal case of disease results from his sentimentality, and is morally responsible for all the suffering which the illness he is a means of spreading may cause!

Communicable Diseases.

Communicable infectious diseases are not contagious in the sense in which that word is used in this classification. Infection takes place in these cases in known and preventable ways. Thus typhoid fever is due to water, milk, or something swallowed which is contaminated with bacteria of the species known as the *Bacillus typhosus*, or typhoid bacillus. The life history of the bacillus is this: It is able to live and multiply in water (especially when the latter contains filth derived from sewers, cesspools, etc.) and in various sorts of soil, provided moisture be present. Taken into the stomach, it passes downward until it reaches the small intestine. There it finds conditions favourable to its growth, and it begins to grow

tion! Isolate the patient as you would a case of smallpox and "make assurance doubly sure." It is not a matter for theoretical discussion, but for practical action. None but a fool would take the risk involved in failing to adopt every precaution, destroying by disinfectants every germ which can be captured, and preventing the wider distribution of such as may have escaped capture when first expelled from the body by confining them within the walls of the sick-room until such time as the room and every article in it can be thoroughly and surely disinfected with corrosive-sublimate solution or heat.

in certain parts of the intestinal walls, causing ulcers to form. It also passes into the blood, and is found in large numbers in the spleen. As the disease progresses myriads of the germs are expelled with the discharges from the rectum. If all the dejecta are thoroughly disinfected the germs are, of course, killed, and no harm comes to other people. If not, and if the germs find their way into drinking water, they infect susceptible persons, who swallow them with the water. The fever does not spread in any way save through the medium of water or other substances contaminated with the excreta of patients. It is therefore *not contagious*, while it *is communicable*. In the case of syphilis the disease is communicated only by direct contact of the sick with the well, or by the introduction of the poison through an open wound by means of the contact of something contaminated with the poison of syphilis derived from the body of a syphilitic. The ordinary way in which infection occurs is well known. Indirect infection has been known to follow the use of a tobacco pipe belonging to a syphilitic, and to wounds inflicted by instruments in the hands of a surgeon operating upon a syphilitic, and various other accidents.

Tuberculosis is also a communicable disease. The bacilli are always expelled from the body of a tuberculous patient in some fluid (usually expectoration), and infection takes place only when some of the germs are swallowed with contaminated food or drink, or inhaled when the fluid which contained them dries and becomes dust. The commonest source of infection is the dry sputum of consumptives. Another very common source is the milk of tuberculous cows. In the case of a human being there is no danger save from the expectoration or from some other discharge containing the bacteria. It is always possible to destroy the dangerous excretions. See *Tuberculosis*.

CHAPTER III.

THEORIES OF INFECTION AND IMMUNITY.

The theories of infection which from time to time have been put forth are very numerous. It is not worth while to concern ourselves with those which have long been exploded. At the present day all scientists accept one theory, and one alone, in explanation of the occurrence of the vast majority of infectious diseases, and but few believe that any of these diseases are caused by anything but a living poison.

The *germ theory*, which has superseded all others, is that infectious diseases are caused by the growth and multiplication within the body of

various species of micro-organisms or germs. In several diseases this theory has proved to be true. In others a germ origin is rendered probable by the constant presence in each case of a particular species of micro-organism, while in still others the course and history of the disorder makes its germ origin a fair inference, although nothing has yet been discovered which we can point to as a specific bacterium. For information about the probable ways in which germs produce symptoms and lesions, see *Bacteria*, *Tuberculosis*, *Malarial Diseases*, and the article on *Surgical Injuries and Surgical Diseases*.

The Germ Theory of Infection.

All human beings are not susceptible in the same degree to infection; some are severely attacked after slight, others suffer lightly after prolonged, exposure; some do not suffer at all. *Immunity from infection means the power of resisting the evil effects of a disease poison.* It is sometimes inherited and sometimes acquired.

Immunity.

Inherited immunity is that which is transmitted through succeeding generations. It is a peculiarity, like other hereditary peculiarities, and is as inexplicable as are all others. It is subject, like the others, to variations in its degree, and it may be wanting in some members of a family, while the others possess it in a marked way.

Acquired immunity results sometimes from prolonged exposure to the infection of certain diseases in a not too virulent form. The system seems to become accustomed to the unhealthful conditions, and from constant battling with milder doses (if I may so express it) of the poison learns to resist stronger ones. The inhabitants of malarial neighbourhoods do not succumb to malarial fever, as do new-comers. They have acquired a certain immunity from the disease by reason of their long exposure to its poison. From certain diseases immunity is acquired if the body be brought up to and maintained in a perfect physical condition; when the general health falls below a certain point susceptibility follows. The physical condition has no influence whatever upon immunity from many diseases, however. Typhus fever, smallpox, and many others, are just as likely to attack the strong as the weak.

There is a very extraordinary form of immunity which is acquired, as in certain diseases; one attack protects from subsequent ones for a longer or shorter time. The possible reasons for this were discussed by the writer in a paper printed in the *Proceedings of the New York Academy of Medicine* for 1893 and in the *New York Medical Journal* for March 18, 1893. It is here reprinted from the *Medical Journal*: *

* The paper was entitled *Acquired Immunity from Certain Infectious Diseases, a Result of Heredity and Natural Selection*, by J. West Roosevelt, M. D.

The various theories which have been advanced in explanation of the protection afforded by one attack of certain infectious diseases from subsequent attacks may be summarized as follows:

1. The pathogenic micro-organism is assumed to exhaust the supply of some substance present in the bodies of unprotected people, which substance is necessary for the nourishment of the parasite, and which, once removed by it, is not reproduced by the body. This is called "the exhaustion theory."

2. The micro-organism is thought to produce within the body some substance inimical to its own existence, and this antidotal substance, once formed, is not destroyed or excreted by the body. This is called "the antidote theory."

3. It is assumed that in a successful struggle with the invading bacteria the body cells acquire an increased strength—become educated, one might say—and thus are able to destroy the enemy. This new strength they transmit to their descendants, so that the body is better able than before to repel subsequent invaders. Thus is established "tolerance" to the poison, as it is maintained.

The first theory may be regarded as untenable for several reasons, among which are the following, which seems to me to be fatal: If we accept it we must believe that Nature has provided man with a number of different substances which can have no conceivable use other than that of providing food and accommodation for pathogenic micro-organisms. These hypothetical substances are evidently not needed by the human body, since, *ex hypothesi*, bacteria remove them and they are not reproduced; yet the patient recovers entirely and is not at all the worse for his illness. It would be hard to believe that this could be the case if provision were only made for the growth and nutrition of some *one species of germ;* but when we are called upon to believe that the majority of mankind come into the world with a separate and distinct "substance" suited to the needs of the micro-organisms of smallpox, measles, scarlatina, chicken pox, vaccinia, yellow fever, and a number of other diseases, the imagination is staggered and the reason revolts against such a preposterous idea. In a sense which will be indicated in another part of this paper, and which was not in the minds of its inventors, it may be said that there is some truth in the theory.

A certain degree of plausibility is lent to the antidotal hypothesis by the fact that, like all living things, bacteria produce by their own vital processes substances which, if sufficiently concentrated, are fatal to the producers. The great objection to it is that we know of no organic compound which is not excreted or destroyed by the body within a short time after its introduction into the system. This makes it hard to conceive that any permanent protection can be afforded by bacterial action.

Of the three explanations suggested, the third—that of acquired tolerance—is nearer to the truth than the others, yet it does not altogether satisfy the mind. While it is free from the objections which apply to the others, it seems to me weak in one important respect. It is perfectly logical to assume that the power of resistance existing in a body cell should be transmitted to its descendants, in accordance with the laws of heredity; but it is an assumption hardly warranted by experience or observation of other biological phenomena which ascribes to cells the power of acquiring and transmitting peculiar resisting powers during a period of stress such as must exist under conditions which obtain in the infectious diseases. It seems to be improbable that such should be the result of their fight.

To me it seems that the objections to the theory vanish if we apply the law of the survival of the fittest to the problem as well as the law of heredity. Let it be supposed that the feebler cells concerned in the struggle are for the most part killed. When recovery takes place the body will resume its original functional activity, but it will contain descendants of the cells originally strong enough to destroy the poison of the particular disease through which it has passed. Naturally the qualities of the parent cells are transmitted to their offspring. It is not so much by reason of new powers acquired by the stronger as by reason of the destruction of the weaker cells that immunity is afforded. This is much more in accord with Nature's methods as actually observed in the whole domain of biology. She seems to prefer to slay the weak rather than to leave them to transmit their weakness to others. The strong survive because of their strength, and in the end this is a benefit, for it tends to perpetuate and improve the species and elevate the type which composes the majority of such species. In the long run it is far better that, relatively speaking, a few individuals should suffer and perish than that the whole number should do so at a later day. The survival of the fittest cells in the human body preserves the whole body from danger, if the theory of immunity set forth in this paper be true. Living cells then form the "substance" assumed in the "exhaustion theory" to be destroyed and never reproduced.

The evidence of its truth is largely derived from a consideration of the action of certain laws of Nature upon living organisms of complex structure—viz., animals and plants. It is therefore not to be regarded as entirely trustworthy. Reasoning by analogy is not true inductive reasoning; it is not based upon observed facts. Analogical evidence should be regarded by the scientist very nearly as circumstantial evidence is regarded by the lawyer. The latter can not be considered as approaching in value the testimony of trustworthy eyewitnesses, but its importance increases with each additional demonstrated fact which tends to show that a certain allegation is *probably correct.* When a sufficient number of facts have been presented in court, which, although they do not directly prove a case, make it extremely probable that certain events have occurred (as the lawyers express it, "show its probability beyond reasonable doubt"), circumstantial evidence amounts almost to proof, and has been regarded by the courts as actually proof. This should be the position of the scientist in respect to any theory which does not rest upon indisputable demonstration. The theory must explain all the known phenomena, and it must conflict with none of them. If based upon analogy, the closer and more evident the analogy the more probable the theory. As time goes on and new observations are made in the light of more extended knowledge, each one which accords with the theory increases the probability of its truth. When all known phenomena confirm it and *no single one fails to agree with it*, it may be considered as proved. It matters not whether the hypothesis was based upon fact or fancy.

It seems to me that this hypothesis is a rational explanation of the immunity conferred by attacks of the diseases under discussion. The fact that attacks of some acute infectious disorders do not diminish the susceptibility to infection does not, as I think, conflict with it. The reasons which justify the last statement will be given in another paper. For the present it is desired only to give very briefly an outline of this theory in its relation to certain others.

If the doctrine of phagocytosis is correct—if the disease process is a direct

conflict between the phagocytes and the invading germs—then surely the weaker cells must perish, and, when the struggle is over, the body must find in the descendants of the stronger a safeguard against subsequent invasions.* If it is by chemical substances produced within the body that the bacteria are overcome, the theory is perfectly reasonable. The bactericide necessarily is a product of cell activity; it is the direct or indirect action of the living tissue elements which determines the constitution of all the secretions and excretions. The blood plasma is no exception. If the latter contains as one of its normal constituents something toxic to certain forms of bacteria when present in sufficient amount, it is because some living cells produce it, as part of their life work. If the presence of the germ determines the production of such a substance, not previously existing in the plasma, it is still by cell activity that it is made. If recovery depends upon speedy elimination of the bacteria or some product of their growth, or something necessary for their nourishment, again it must be accomplished by body cells. It might be that the micro-organisms of some diseases can only flourish by killing certain cells, directly or indirectly. Whatever be the method of attack or defence, the struggle is between germ and cell. The living tissue elements which are least able to withstand the stress of the conflict must succumb sooner than their stronger fellows; it matters not whether the weakness results from lack of sufficient destructive power as a phagocyte, or of sufficient power to produce an unusual quantity of some bactericide, or of adaptability to changed environment sufficient to manufacture some offensive or defensive substance different from that previously produced, or to withstand the deleterious effects of some product of bacterial life, or to remove some substance necessary for bacterial nourishment, or to do any work in the fight of any sort.

It may be objected that there is no proof that cells inherit qualities possessed by their ancestors. There is no direct proof; but to deny the fact would be equivalent to asserting that the whole is not equal to the sum of all its parts, for the hereditary peculiarities of animals are admitted, and animals are composed of multitudes of cells. If the latter do not inherit and transmit certain peculiarities, how can the former? If spermatozoon and ovum are able (as they unquestionably are) to influence so powerfully the development of the entire body as to cause physical or mental characteristics to recur generation after generation, it is impossible to conceive that this result can be produced unless *every generation* of their descendants (the body cells) receives and transmits hereditary traits.

It seems equally inconceivable that the law of the survival of the fittest, which is of universal application throughout the whole animal and vegetable world to each individual animal or vegetable of every species, should fail to apply to every cell forming part of these individuals. No reasonable explanation can be (or, at all events, has been) adduced of the existence of such an anomaly in Nature.

It is a much more plausible supposition that qualities already possessed congenitally by the cells should be transmitted to descendants than that those acquired in a short, fierce struggle should be transmitted. Indeed, the possibility

* Phagocytosis is a term applied by Metschnikoff to the peculiar faculty possessed by certain cells of taking into their own bodies—devouring, as it were—various minute objects, like some bacteria, and destroying them.

of the transmission of acquired traits is denied by some biologists. Of the congenital traits there is no doubt.

Of this theory it may be said, at least, that it is very fascinating. Is it not also suggestive and plausible? Is it not worthy of consideration as a working hypothesis, if nothing more? In another paper I shall discuss in detail the application of it to a number of diseases, and also to the protective effects of inoculations with attenuated virus and with vaccine.

CHAPTER IV.

BACTERIA.

Classification.

Bacteria (singular, *bacterium*) is a term applied to a large class of living vegetable organisms of microscopic size, each consisting of a single cell of very simple structure. The class includes a number of genera, each genus containing a great many species. There are many difficulties in the way of making a satisfactory classification of the various kinds of bacteria, and much doubt exists as to many of the kinds observed, whether they can properly be considered as separate species or mere varieties. Indeed, the whole system of nomenclature now in vogue must be regarded as nothing more than a convenient, temporary means of expression, which will probably be extensively altered as the knowledge of the subject becomes more precise. In spite of the immense amount of work done by thousands of enthusiastic, patient, skilled observers, who have devoted years of their lives to the study of these organisms; in spite of the brilliant intellectual abilities of many of these investigators; in spite of great advances in technique; and in spite of the enormous importance of some of the ascertained facts—the science of bacteriology is still in its infancy, and our positive knowledge of bacteria is as yet very small.

Size, Shape, and Movement.

Bacteria are of many shapes and (although all of them are so small as to be visible only when highly magnified) of many sizes. Some of them are shaped, roughly speaking, like rods; others are spiral in form, like a corkscrew; still others are spheroidal or ovoidal, like a ball or an egg. The differences in shape serve as one of the distinguishing marks of the various genera and species.

Rod-shaped bacteria are called *bacilli* (singular, *bacillus*). They are sometimes long and thin, sometimes short and thick, and, although usually almost straight, some of them are more or less curved. They are occasionally thicker at one end than at the other. See Figs. 1 and 2.

The spiral forms are called *spirilla* (singular, *spirillum*). Spheroidal and ovoidal bacteria are called *cocci* (singular, *coccus*). This term is rarely used except as part of a compound word which indicates the genus to which the particular coccus belongs. Thus we speak of *micrococcus*, a genus containing a large number of species of spheroidal form; *staphylococcus*, a genus characterized by the peculiar grouping of the germs in masses like a bunch of grapes; and *streptococcus*, a genus in which the cocci have a tendency to grow in the form of chains.


Fig. 1.—The bacillus anthracis. (After De Bary.)

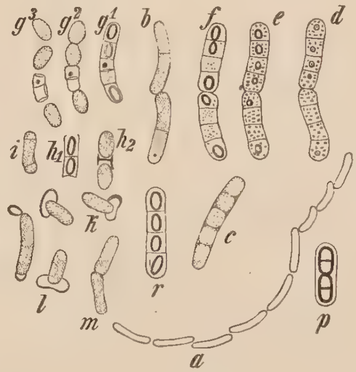


Fig. 2.—The bacillus megaterium. (After De Bary.)

Rod-shaped and spiral bacteria frequently have the striking peculiarity of moving about with greater or less speed. Some of them produce this movement by means of extremely delicate hairlike processes (*cilia*) which move rapidly in much the same way as an oar used in skulling a boat, and thus propel the body. In others the mechanism causing the movement is not known. Cocci are always motionless.

Propagation.

Bacteria propagate in a very simple way. The parent cell divides into two. It can not be said of the offspring that either is the descendant of the other; each contains one half of the ancestor, and both appear simultaneously with the disappearance of that ancestor. There *was* one bacterium—there *are* two. That is all that can be said about it. The rapidity with which reproduction occurs in some species, under favourable conditions, is enormous; a single germ, could the necessary favourable conditions be maintained, so that the observed birth-rate (if I may call it so) continued for twenty-four hours, would produce between 16,000,000 and 17,000,000 descendants. Of course such an enormous rate of increase can not be maintained, for if it were, this earth would long ago have been devoid of all forms of life, since the bacteria would, within a few days, have exhausted every chemical compound necessary to life which the whole world contained, and there being nothing left to feed upon, all living things would have ceased to exist.

The conditions necessary for the maintenance of bacterial life vary

PLATE III

1

…imary forms of bacteria (…idal, rod-like, and spiral).

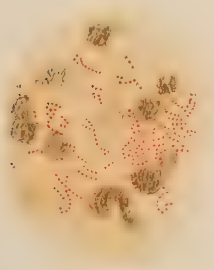
2

Spheroidal bacteria (cocci) in pairs (Diplococcus).

3

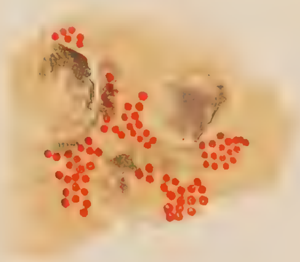
Cocci in chains (Streptococcus).

4



…coccus pyogenes in pus.

5

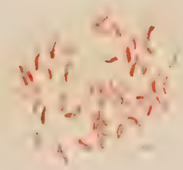


Staphylococcus pyogenes in pus.

6

7

8



EXAMPLES OF MICRO-ORGANI[illegible]

somewhat among different species, but the variations occur only within pretty narrow limits. Like all living things, these tiny organisms can not survive if exposed to too high temperature. Most of the known species are killed if exposed for a short time to boiling water, or to steam at a temperature equal to that of boiling water. Some forms, however, when in the state known as spores, are able to survive boiling for some hours. In general, bacteria seem able to survive prolonged cold far below the freezing point of water, for Prudden and other observers have repeatedly shown that ice obtained from streams, lakes, and ponds always contains numerous germs which actively propagate their kind when the ice is melted and the water raised to a suitable temperature. It is important to note in this connection that the bacteria which cause typhoid fever have been kept for weeks in ice exposed to a temperature below zero, and have subsequently been found capable of most active and vigorous growth. Drying bacteria, if the process be conducted in a moderate heat, suspends temporarily the vital activity of all known forms, and kills some species—*e. g.*, the bacilli of Asiatic cholera—but many species revive promptly when again exposed to moisture, even though they have been kept a long while in the dry state. The *Bacillus tuberculosis* survives many months in this condition, and for this reason the dried expectoration of consumptives which is so easily scattered into dust is a source of great danger to those who inhale it. Curiously enough, many bacteria are killed in a rather short time if exposed to bright sunlight, especially if they be dry when thus exposed. Certain chemical substances prevent the active growth of bacteria and, if strong enough, kill them.

The Struggle for Existence.

It will be seen from the foregoing brief sketch that the germs are pretty well fitted to maintain the struggle for existence, at least so far as their ability to survive amid very different surrounding conditions is concerned. They simply cease to exhibit active signs of life when the surroundings are not favourable—remain in a latent state, as one might say—and subsequently resume their activity when the surroundings again become favourable, provided the unfavourable conditions are not continued too long and are not necessarily fatal. In order to make possible the exhibition of the phenomena of active life, bacteria require a far narrower range of variation in their environment than those mentioned as compatible with their mere survival in the inactive state. Frozen bacteria may not be dead, but while frozen do not show any sign of life. They do not reproduce their kind, and, so far as can be shown, do not seem to cause any of the chemical reactions which are produced by active living things. A certain amount of heat is necessary before these can be brought about under the influence of the mysterious something called life. Besides warmth, some degree of moisture is necessary, and some substance to fur-

nish food (that is to say, some chemical compound which the living being adapts to its use as fuel and as material wherewith to build up its own body until it is able to propagate). Certain species require, besides warmth and moisture, the presence of oxygen in large amounts, and only grow in contact with the air; others do not need more oxygen than they can obtain beneath the surface of the fluid or semifluid in which they are placed.

The enormous potential rapidity of reproduction among these micro-organisms has been mentioned. We shall now consider what limits their actual increase, so that they do not literally devastate the earth by their overwhelming numbers. Among the forces which tend to check the excessive multiplication are the action of sunlight, which doubtless kills countless myriads, especially those which the wind has dried; of the winds, which scatter them far and wide, and often remove them from places where the surroundings are favourable to places where they must die, because conditions obtain in which they can not get the needed food; rain and melting snow and ice, like winds, must kill many, as the running water scatters them far and wide. Some fall victims to organisms of higher and more complex types, myriads are swallowed daily by man and all other animals, and vast numbers of these perish in the digestive tracts of their hosts, although some are expelled unharmed; and some, finding in the animal body conditions favourable for their existence, remain and multiply rapidly. *The most destructive foes of bacteria, however, are bacteria*, and the extreme rapidity with which reproduction takes place is one of the most important causes operating to prevent these organisms from becoming too numerous. The last statement may seem paradoxical, but is not. Extremely rapid multiplication implies an equally rapid increase in the consumption of food, and therefore, unless the supply be inexhaustible, hastens the time when none remains to support life. Even though there may be food enough for all, it can not be obtained by the bacteria which happen to be surrounded by hosts of others, which devour the food before it reaches the former, and so these starve. Overcrowding causes death in a way other than by starvation. All living things excrete substances which, when sufficiently concentrated, are poisonous to themselves and to others of their species. When bacteria become so numerous that their own poisonous excreta reach a certain degree of concentration they either die or, at least, cease to multiply. There is yet another way in which bacterial increase is kept in check—certain species seem to have the power to prevent certain others from multiplying side by side with themselves. In some instances, doubtless, this is simply because the superior vigour of one species enables it to deprive the other of needed food, but in others it appears that the vital processes of the former result in the production of chemical substances poisonous to the latter.

Causes Tending to check Increase.

CHAPTER V.

BACTERIA AND DISEASE.

It is a great mistake to suppose that all bacteria are injurious to health. Only a few species cause disease, and of the other species not only are the great majority harmless—they are extremely useful. Indeed, were it not for the activity of the countless billions which are silently at work changing dead animal and vegetable matter into useful substances, life would be impossible upon earth. They prepare food for all the rest of the world; they make the soil rich by decomposing all dead things and whatever has been cast away by beings of higher orders when it has served their purposes. Dead leaves, for example, can not possibly be of further use to the tree until they have rotted. Bacteria attack the leaf and get from it what is needed for their own life. In so doing they cause it to fall to pieces, and also produce new compounds with gases absorbed from the air which are suitable for the use of growing plants and trees, and are taken up by them. When the bacteria themselves die, their bodies, in a similar manner, are decomposed, and what they had taken from the leaf is given back to the soil in a useful form. It will be seen that all living things literally return to the dust whence they came; they merely borrow a few elementary substances and arrange them in new combinations by means of a little energy lent them by the sun, and after a while that which we call life is gone, but leaves behind all that it had borrowed both of energy and of matter. After death the body of the highest animal—man—becomes food for lower forms of living things, and at last its constituents are prepared by the bacteria for the support of higher vegetable life, to be further prepared for supporting life in animals. Were all bacteria to be destroyed, all life would soon end, for all the elements necessary to maintain it would be shut up in the bodies of the dead.

Not all Bacteria are Harmful.

Although most bacteria are harmless, some species are the cause of sickness and death when they gain admittance under certain conditions to the body. They cause suppuration (see the article *Surgical Injuries and Surgical Diseases*) and probably all other infectious diseases except malaria, which is caused by a micro-organism which is not a bacterium. (See *Malarial Fevers.*) The following is a brief sketch of the most widely accepted theories concerning their relations to disease. The bacteria which cause disease are called *pathogenic* (from two Greek words meaning sickness-causing), and I shall use that term for convenience in this article.

Injurious Bacteria and their Effects.

Pathogenic bacteria differ from non-pathogenic in that they possess

the power of surviving and multiplying under the conditions which exist in the bodies of certain human beings and other animals; they are able to obtain needed nourishment from the tissues of their hosts, and, for a longer or shorter time, to withstand the efforts which the body cells make to destroy or expel them. When they have once gained admittance to a susceptible animal's body they produce evil symptoms which vary greatly in kind and in severity, according to circumstances. The symptoms depend partly upon the species of germ, partly upon the virulence of the particular individuals of species which happen to take part in the infection, partly upon their situation in relation to various organs and tissues of the body, partly upon the degree of resisting power possessed by the body cells, and partly upon the number of germs which find their way into the body at any one time—*i. e.*, upon the size of the dose of poison.

In using the word "species" I do not wish to be understood to assert that it is absolutely proved that clearly defined groups of bacteria exist having characteristics so constant and striking as to justify the term in the sense in which we apply it to groups of higher types; I merely use it for convenience. Bacteriologists speak of various "genera" and "species," but they do not regard any classification thus far suggested as anything more than provisional. Thus they speak of bacteria which cause tuberculosis (*Bacillus tuberculosis*) just as botanists speak of a definitely recognised species of plant, like *Papaver somniferum*, the opium poppy; but the so-called genus *Bacillus* has only one characteristic—namely, its shape like a rod—whereas the genus *Papaver* has a number of peculiarities which distinguish it from other genera; and the species *tuberculosis* is recognised only by certain peculiarities of behaviour when dyed with certain aniline colours, and certain peculiarities in the conditions necessary for its growth when cultivated outside of the animal body, and the fact that it causes certain anatomical changes when it grows in the body, while the species *somniferum* has many much more decided specific characteristics. The *Papaver somniferum* produces, among other substances, morphine, which, when administered in sufficient doses, gives rise to certain symptoms in man. The facts that a plant contains some substance which resembles morphine in its effects upon the human body, that it requires certain conditions of soil and climate for its growth, and that some invariable chemical reaction occurs when certain tests are made, are not sufficient to justify the assertion that it is the *Papaver somniferum.* The assertion that the *Bacillus tuberculosis* belongs to one species is based upon hardly better evidence. This is, however, merely a matter of theoretical interest, for the important fact is that certain rod-shaped germs, having the peculiarities mentioned, are expectorated by consumptives, and that these germs may cause consumption in any one whose system they enter. We do not know the ancestry of tubercle

bacilli. We do not know whether any harmless bacillus may, under certain conditions, become endowed with the terrible power of making tubercles. We only know that the bacteria which grow in a certain way upon certain culture media, and react in a certain way to dyes, cause tuberculosis; and because of their shape and their pathogenic power we give them the name.

Pathogenic bacteria sometimes attack and destroy, or injure more or less severely, some organ or group of organs or tissues, and produce symptoms indicative mainly of the local mischief done. In the case, for example, of a boil, the principal symptoms are due to the local lesion with its painful swelling. Again, these germs may give rise to general symptoms only, as in typhus fever, where no one organ seems to be the particular seat of the trouble. Local diseases are, however, almost always accompanied with symptoms of general disturbance. With the boil comes fever and its discomforts, as well as the painful local inflammation.

I have said the species of germ has much to do with the kind of symptoms produced, and I have also stated that the virulence of particular individuals of the same species differ. It is possible to cultivate certain pathogenic bacteria and, by modifying the culture media or the other conditions under which they are grown, to intensify or to lessen their virulence. Pasteur asserted that he had done this so completely as to transform the most dangerous of microbes into entirely harmless organisms—indeed, he believed that he had so modified some of them as to make them useful in preventing the very diseases which, in their virulent condition, they produce. Be this as it may, there is no doubt that germs of the same species differ markedly in their poisonous properties, and that the virulence of the latter can be greatly affected by artificial means. Since it is shown to be possible to change a virulent into a harmless microbe, there is reason to think that harmless species may become changed into virulent ones, although proof that this takes place is lacking.

The importance of the situation occupied by germs in determining the symptoms produced by them is best shown in the case of the bacteria of suppuration. When these invade a wound in some part of the body where no important organs are involved, the wound becomes inflamed and painful, pus forms in it, and the tissues in the immediate neighbourhood become more or less involved in the process. The general symptoms of fever appear, but the only result is the formation of an abscess which finally discharges itself, and the symptoms subside. The case is different when an important organ like the liver or brain is involved, for now the patient not only suffers from the formation of pus, but also from the injury to the affected organ. Here we have an example of difference in effects due to difference in the situation in which the microbes are

placed; but there is another and more striking difference when the germs find their way into the general circulation and, instead of growing in solid tissues, multiply in the blood itself. Violent general symptoms ensue, abscesses (large or small) form rapidly in different places, and we have what is called pyæmia, which usually ends in death.

In order to understand why there is such a great difference between bacteria floating free in the blood and the same bacteria confined in some isolated locality, it is necessary to bear in mind the fact that suppuration is a fight between the white cells and the bacteria. When the latter are fastened in the tissues the former are able to gather in large numbers and attack in the most effective manner. The white cells do not have the power of pursuing their enemies in the fluid blood, like fish in pursuit of their prey; all they can do is to attack those with which they come in contact; in the blood current the bacteria are at an advantage. As a result of the bacterial activity, or of that of the body cells, or of both, fibrin begins to form and to entangle in its meshes numbers of the enemy. The germ-laden masses of fibrin become large enough to plug small arteries, and immediately the white cells attack the bacteria thus arrested in their course. Cells and germs multiply, and an abscess forms wherever one of the little plugs of infected fibrin lodge.

The general symptoms which accompany suppuration, as well as those accompanying other infectious processes, seem to result from the action of poisons which are formed by chemical changes produced by the growth of the germs within the organism. In some instances it is possible, by cultivating certain pathogenic microbes in suitable culture media in the laboratory, and subsequently sterilizing the cultures by heat—thus making it impossible that any effects produced can be due to the growth of the bacteria when subsequently the fluid is introduced into the system—to make compounds which, when injected in very minute quantities into the circulation, produce the same symptoms as are observed when the same organisms are in active growth during an attack of infectious disease. Thus the bacteria of erysipelas (a disease in which there is intense local inflammation of the skin, due to the presence in it of the actively growing germs, and also marked general symptoms, such as chilliness, fever, rapid and weak pulse, prostration, nausea and vomiting, and often diarrhœa), if cultivated in beef broth and peptones, cause chemical changes in the broth of such a nature that a few drops of it, after sterilization, give rise to all the symptoms of severe erysipelas, *except the inflammation of the skin*, within a half hour after being injected hypodermically. This shows that the general symptoms are due to the *poisons* generated in the infected skin, while the local ones are due in large part to the presence of the living and multiplying germs themselves, which act as irritants.

Another example of the indirect action of germs is found in Asiatic cholera. In this disease the bacilli do not enter the body tissues to any extent; they simply decompose the contents of the digestive tube and generate a virulent poison which is absorbed in the intestines in the same way that a poison administered by the mouth is absorbed, and the symptoms result from the action of this poison.

When growing within the body, bacteria react toward the body fluids just as they do toward any fluids in which they can grow—viz., they produce new compounds by decomposing those already existing. The souring of milk is caused by a microbe which produces, among other substances, lactic acid by decomposing the sugar of milk, and the microbes of putrefaction give ample proof to the nose that they make of animal substances new and most offensive compounds. I have already mentioned that the products of bacterial life are themselves poisonous to the producers. In many diseases it is apparently for this reason that recovery ensues: the microbes poison themselves with their own excreta. In the case of diphtheria, the fact that its bacilli make something which helps the body to kill them has been utilized in the antitoxine treatment. That method consists in increasing the amount of the antitoxic substance in the blood of horses by infecting them with the concentrated poison from cultures of the bacilli a number of times at certain intervals. After a while the horses fail to show any symptoms after receiving the injections. The serum of those horses is used to inject into human beings, and it decidedly modifies and makes milder and shorter existing diphtheria, and also prevents infection if injected in cases exposed to the contagion but not yet sick.

CHAPTER VI.

ASIATIC CHOLERA.

Asiatic cholera is an acute infectious, non-contagious, but communicable disease caused by a specific germ, the *Bacillus choleræ asiaticæ*, which is taken into the system with infected water or food, and in no other way.

Cause: The Cholera Bacillus.

The cholera bacillus was discovered by Robert Koch in the course of an investigation in Egypt undertaken by him when a severe epidemic of the disease was raging in that country. His studies and experiments leave no doubt that the microbe is the cause of the disorder, and that it is the *only* cause. This does not mean that the bacillus, if swallowed by a perfectly healthy person, necessarily produces cholera; it means that unless the bacillus is intro-

duced into the digestive tube under conditions which permit of its growth there, cholera is not possible.

The microbe is a minute bacillus, about one third the diameter of a red blood-disk in length, which multiplies rapidly in fresh water, and which is found in immense numbers in the dejecta of cholera patients. It is slightly curved, and from its shape is often called the *comma bacillus.* It can not be recognised by its shape alone, or by any other peculiarity, except the manner in which it grows on different nutrient culture media. Comma-shaped bacilli are numerous, but the cholera bacillus forms certain peculiar colonies on potatoes, in gelatin peptone, and on agar peptone, which, together with its shape, distinguish it from all other known species.

It is very easily killed by drying, especially if exposed to direct sunlight. It grows vigorously in *fresh water* when the temperature of the water is not too low, but it dies in a few hours in *salt water*, and never, therefore, is a means of infecting fish, oysters, clams, lobsters, or crabs, in the way certain ignorant people asserted that it might do. Weak acids kill it immediately, and the normal acidity of the gastric juice is an efficient protection against cholera in healthy people. This acidity is not always maintained, however, especially in hot weather; slight attacks of indigestion are frequent, in which the reaction of the stomach contents become alkaline, and when this occurs the germs easily pass through it into the intestines, the contents of which are normally alkaline. Here they begin actively to multiply, and, save in a very few cases, the symptoms of cholera rapidly supervene. *It should be borne in mind during an epidemic of cholera that there is not the least need of getting the disease. If a person drinks only sterilized (boiled) water, which is kept in sterilized vessels, and eats only properly cooked food, and keeps his hands free from contact with cholera discharges (or, if obliged to handle these discharges, or clothing soiled with them, carefully washes them immediately in water containing corrosive sublimate or a small proportion of acid), that person will not get cholera.*

There are three stages in a typical case—the stage of *invasion*, the stage of *collapse*, and the stage of *reaction*. Sometimes there is a short stage of what is called the prodromal diarrhœa.

Invasion.

The invasion is usually very sudden. The patient while in perfect health, or perhaps after a few hours of slight intestinal disturbance, begins to have a number of loose, painless, watery, diarrhœal movements. At the same time he begins to feel weak and very ill. The movements soon change in character; they become more and more liquid and more and more colourless, until at length they look precisely like rice water with a few white lumps or shreds floating in it. Nausea and vomiting are commonly early symptoms.

Collapse follows in a few hours and the patient is completely prostrated, pale, or even bluish in colour; the body, and especially the extremities, become very cold; cramps occur in various muscles, respiration is sighing and shallow, the pulse so weak as to be imperceptible, the urine is suppressed, the rice-water discharges may be almost continuous; consciousness is retained to within a few minutes of the end in fatal cases.

Collapse.

If the patient survive this stage it is followed by the reaction. The discharge diminishes in quantity, the pulse becomes perceptible at the wrist, the cold extremities become warmer, and the temperature in the rectum, which had fallen during the stage of collapse to 97°, or even 96° to 95°, rises. Some urine may be excreted, which is, however, loaded with albumin, and is usually bloody. Soon fever sets in, and the temperature may reach 102° to 104°. With the fever comes headache and delirium. Now follows either one of two results: (1) The patient may go on, with diminution of all the symptoms, to complete recovery, or (2) he may become comatose, the urine again being suppressed, and death may occur within twenty-four to forty-eight hours.

The Reaction.

The treatment of cholera after the disease has fairly begun is unsatisfactory. From fifty to seventy-five per cent. of the cases die. By far the most important treatment is that which *prevents*—namely, avoiding infection. Nevertheless, the disease is peculiar in this respect: the bacteria do not enter the blood, but produce their evil results by decomposing the contents of the intestinal canal, and producing therein poisons which are absorbed by the system, and in turn produce the dangerous symptoms. For this reason it is possible to hope that something will be discovered which will kill the bacilli in the intestines without injuring the patient.

Treatment.

At present the best we can do is to give stimulants and remedies calculated to combat the symptoms, but there is not much faith to be placed upon any of them.

CHAPTER VII.

MALARIAL FEVERS AND CHRONIC MALARIAL POISONING.

The cause of malarial diseases is infection with a micro-organism which is not to be classed with the bacteria. It is called the *Plasmodium malariæ*, and it is found in the blood serum, the red blood-disks, the white blood-cells, and in various organs. It varies considerably in shape and size, and sometimes appears motionless, sometimes in active motion.

The accompanying illustrations (Figs. 3, 4, and 5), with their descriptions, will give a better idea of its appearance than can be conveyed in words. It may be found in all cases of malarial disease during an acute outbreak, *provided quinine has not been administered in efficient doses.* This drug prevents its growth in the system, and when a very weak solution of it is brought in contact with actively moving plasmodia, while they are being observed under the microscope, it instantly arrests all motion and apparently kills them.

The Cause of Malarial Diseases.

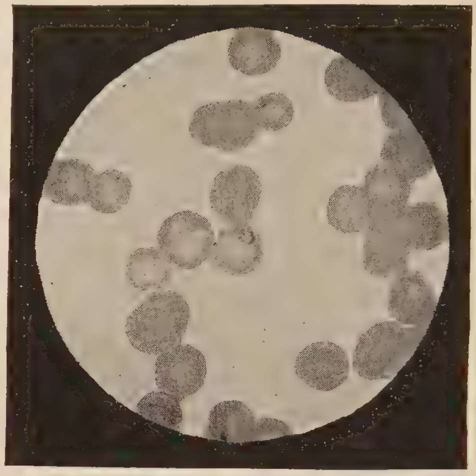


Fig. 3.—Young native parasite inside red blood-cell with nucleus, no pigment. × 1,000.

Ehrlich dried specimen stained with methyl-blue. Zeiss immers. $\frac{1}{12}$, projec. ocular 4. Calcium light.

While we know a great deal about the behaviour of the germ within the body, we know practically nothing about its life history elsewhere. No attempts to cultivate it outside of the living animal have been successful, and the conditions which it requires for existence in malarial districts are no better understood than before it was discovered in the blood of patients. We know that a considerable elevation of temperature is one requisite for its development, for malaria does not exist in cold climates, nor does infection occur in temperate climates when the weather is decidedly cold, and the most virulent forms of fevers occur only in the tropics, or in regions without long and severe winters. A certain amount of dampness of soil is also necessary, and low-lying swamps and marshes and the vicinity of stagnant ponds are notoriously dangerous regions. If the swampy ground happens to be in the tropics, fevers of the most malignant kind are apt to be bred in

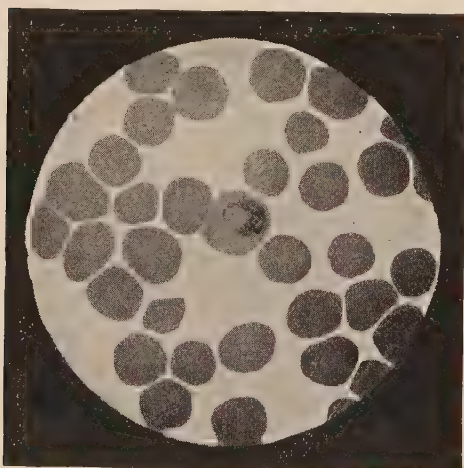


Fig. 4.—Young parasite inside swollen red blood-cell, the tips of the crescent holding the hyaline nucleus. × 1,000.

Same as above in stain and preparation.

them. It is not necessary that the wet ground should be upon the surface, for a swampy layer underlying a pretty thick stratum of sand and gravel may be infected.

An elevation of four or five thousand feet above the sea-level is usually free from malaria, and it is said never to be met with above the height of seven thousand feet. The boundaries of malarial and non-malarial districts are often quite sharply defined. Sometimes a range of hills or a belt of forest divides them; but sometimes regions within a few miles of markedly malarial districts, and having no apparent difference of physical geography and separated by no visible barrier from them, are perfectly healthful. It is not safe, however, to assume that the uninfected region will long remain so under the conditions last mentioned, for one of the peculiarities of the poison is that it slowly invades larger and larger areas of territory, provided soil and climate permit.

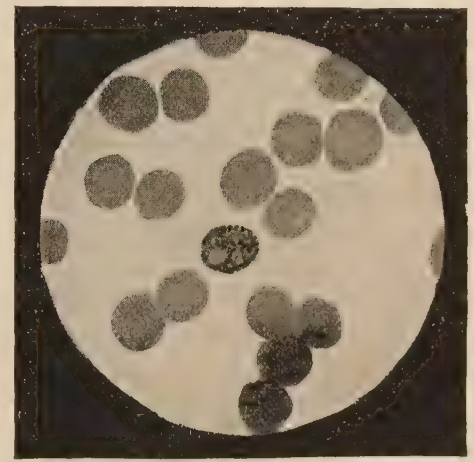


Fig. 5.—Fully developed parasite, rods of pigment arranged in round areas, nucleus indicated by opening, also vacuoles. × 1,000. Stain, preparation, and lens as above.

There are certain facts about the behaviour of malaria which are of much practical importance. These should always be remembered when one is in malarious regions. It is well known that in such regions any extensive disturbance of the ground (such as making excavations for any purpose, building railway embankments, and the like) increases greatly the virulence of the poison, and is followed by a marked increase in the number of cases. Therefore the less of such work the better. Moreover, there is no better protection than that afforded by thick sod, and where grass can be grown, dwelling-houses should be surrounded by well-kept lawns, unbroken by flower beds, free from shrubbery, and not too much shaded by trees. It is important, of course, to drain marshes when this can be done; but it must be borne in mind that the first effect of drainage is usually to increase the unhealthfulness of the region for a time, until the land previously covered by water has become dry.

Susceptibility to malarial infection is greater in newcomers than in residents of infected districts who have lived amid the germs for a long time, and have also become used to the climate. Negroes are far less susceptible than whites to tropical fevers, and natives of the tropics,

of whatever race, less than visitors from the temperate zones. Exposure to the hot sun, overexertion and fatigue, sudden chilling of the body, and exposure to damp night air all add greatly to the risk of infection. To this list of predisposing causes should be added feebleness of body, no matter how brought about, and intemperance.

MALARIAL FEVERS.

The most striking characteristic of diseases due to malarial infection is the regularity with which their symptoms tend to recur at fixed intervals. This peculiarity gave rise to a name sometimes applied to them, *periodic fevers.* There are certain types in which the symptoms occur in paroxysms separated from one another by intervals of comparative or absolute good health. These types are called *intermittent fevers.* Another type, in which there is no period of complete absence of symptoms, but only a decided improvement between the paroxysms, is called *remittent fever.*

Lesions.

The morbid changes found after death from malarial fevers are essentially the same in all forms. The spleen is enlarged, hard, and dark-coloured, with deposits in it and in other organs of pigment derived from red blood-disks which have been destroyed by the plasmodium.

INTERMITTENT FEVER.

Definition.

An infectious, non-contagious, non-communicable disease, caused by the *Plasmodium malariæ*, and occurring in paroxysms which recur at intervals of twenty-four, forty-eight, or seventy-two hours, or sometimes of seven days. Each paroxysm, in fully developed cases, is marked by a chill followed by high fever, which subsides with profuse sweating.

Synonyms: Fever and ague; chills and fever; marsh or swamp fever.

Symptoms.

The onset is sudden, although there may have been a few days of slight discomfort before the first paroxysm. The patient is seized with a severe chill. The skin becomes cold and rough, with "goose-flesh." The face is pale; the lips blue; the nose looks shrunken; the hands and feet shrivelled; the teeth chatter and there is severe shivering; nausea and vomiting often occur; there is marked weakness; the pulse is small and feeble. The chilly stage may last from a few minutes to an hour or two. It is followed by the stage of fever.

The shivering ceases and the sense of cold gives place to a feeling of warmth, followed by a feeling of extreme heat. The skin flushes and becomes hot and dry; the pulse grows strong and hard; severe headache, throbbing in character, sets in; sometimes there is even delirium; the patient is restless and irritable. The stage of fever lasts several hours.

Next comes the stage of sweating. The internal temperature of the body is elevated even during the chill; in the stage of fever not only is the internal but also the surface temperature much above the normal, frequently reaching 105° to 106° Fahr. With the commencement of the sweating it falls rapidly. At the same time the other symptoms of fever disappear, and soon the patient falls asleep, to awaken more or less weak and languid, but otherwise little the worse for the attack. Either before or during the sweating stage, diarrhœa in the shape of one or two loose passages may be observed.

The entire paroxysm may last from three to eight or ten hours. At almost exactly the same hour, usually on the second day after the attack (sometimes on the first day, the day immediately following it, and more rarely on the third day), a similar paroxysm occurs; and the same thing takes place at the same intervals for an indefinite time unless checked by treatment.

Such is the history of a typical case of intermittent fever of average severity. There are mild cases in which the chill is so slight as hardly to be noticed; or fever alone comes on, with or without subsequent sweating; or instead of fever, chill, or sweat, the patient suffers from some of the other symptoms—most frequently headache and general aching in the bones and muscles—which come on at regular intervals. In warm climates, and particularly in tropical and subtropical countries, very dangerous forms are found. These are called

PERNICIOUS INTERMITTENT FEVERS.

After one or two attacks of simple intermittent type such as has been described, the symptoms take on a new character. The chill, instead of being followed by fever, may be prolonged, and the patient pass into collapse and die. Or the fever may be accompanied by violent delirium which merges into fatal coma. Or during profuse sweating heart failure may take place. Sometimes diarrhœa and other symptoms resembling cholera take the place of the usual ones, and death ensues; and sometimes hæmorrhages from the mouth, nose, bowels, or other mucous surfaces, or in the tissues of the body, show the pernicious character of the attack. While simple intermittent fever is not dangerous to life, pernicious intermittent is extremely fatal.

REMITTENT FEVER.

Definition. A disease caused by the *Plasmodium malariæ*, characterized by fever which is continuous throughout the attack, but which has marked exacerbations and remissions occurring at regular intervals. It is infectious, non-contagious, and non-communicable.

Synonyms: Malarial fever; typho-malarial fever; bilious remittent

fever. Both remittent and intermittent fevers are often called by the name of some place in which they are common, as Panama fever, Chagres fever, jungle fever, coast fever, African fever, etc.

Remittent fever is not common above the latitudes of mild winters. In New York there can be no doubt that other diseases (particularly typhoid) are often mistaken for it.

Symptoms.

Remittent fever occasionally begins as a simple intermittent with daily paroxysms, each of longer duration in the fever stage, until finally the chill and sweat are absent, and the fever, with high temperature at night and marked morning remission, remains; thus intermittent passes into remittent. More frequently there is no intermittent beginning; the disease is remittent from its onset. Sometimes there are a few days of slight general discomfort, with aching limbs, back, and head, restlessness at night, and loss of appetite, followed by a chill or slighter chilly sensations. Sometimes the disease begins suddenly with a chill and without any preliminary symptoms. During the first few days there is apt to be pain in the muscles and bones, prostration, headache, furred tongue, a temperature which is higher each evening than it was the previous evening, while at some time of the day—usually the early morning—it falls for a while nearly or quite to normal. After from five to seven days the temperature tends to rise and fall daily through nearly the same range—from 100° in the morning to 104° to 105° in the evening. This it continues to do for a variable period (from a few days to a fortnight), and then the evening rise becomes daily less until at last it ceases to occur, and convalescence is begun. Throughout the attack there is disturbance of the nervous system—headache, restlessness or delirium, and general pains. The tongue is at first coated white; later it often is brown and dry. The bowels are usually constipated; the appetite lost; nausea and vomiting are common; thirst is often intense. The pulse is frequent and hard in the earlier stages; later it is apt to become weaker and more frequent. Sweating is often observed, particularly in the later stages. Examination of the abdomen shows that the spleen is enlarged. This fact can be demonstrated only by a skilled observer. There is often tenderness on pressure over both liver and spleen. In severe cases a certain degree of jaundice may be present. Examination of the blood, both in remittent and in the paroxysms of intermittent fever, shows plasmodia, unless quinine has been given in large doses.

The most frequent complications are acute catarrhal inflammations of the digestive organs and of the lungs. Some cases become pernicious in character, and their symptoms then resemble those of pernicious intermittent. The prognosis is, on the whole, good, provided efficient treatment is undertaken early. In the tropics, and in warm countries near the tropics, remittent fever of a severe and dangerous type is quite com-

mon, and the patient's chances are better in proportion to the prevailing severity of the poison in the neighbourhood. The drug with which malarial fevers should be treated is quinine. It should be given in doses of not less than twenty grains a day to adults for simple intermittent of ordinary severity. For some severe cases thirty to forty-five grains a day may be required. Pernicious cases call for from sixty to one hundred and twenty grains, and in such cases the drug should be given hypodermically and by the rectum, as well as by the mouth. In remittent fever the dose should be given at the time when the temperature is lowest. The efficacy of quinine is often increased if it be administered with some purgative, like calomel, or, as it is in Warburg's tincture, with several aromatic and purgative vegetable substances.

Complications, Prognosis, and Treatment.

CHRONIC MALARIAL POISONING.

In malarial regions some people seem to become accustomed to the poison and live in comparatively good health. Others have a number of acute attacks and then become weak, very pale, with a slightly yellowish pallor, lose flesh and appetite, suffer from neuralgia and other pains, and, in bad cases, become dropsical and die. They always have a spleen greatly enlarged, and it may be so large as to occupy a good part of the abdomen, forming an easily felt tumour—an "ague cake," as it is called. Such patients are not much benefited by quinine, but sometimes arsenic helps them. The greatest need for them is to leave the malarial district as soon as possible.

Chronic malarial poisoning may appear in the form of long-continued slight fever accompanied by great general discomfort and, it may be, by periodic attacks of neuralgia or headache. Such should be treated by a full dose of quinine and arsenic, and, if possible, should remove to a more healthful region.

In chronic, as in acute cases, the plasmodium is present.

CHAPTER VIII.

YELLOW FEVER.

Yellow fever is an acute, infectious, communicable, non-contagious disease characterized by fever and prostration, and often accompanied by jaundice.

The specific germ of yellow fever has not yet been discovered. That it is a germ disease is hardly to be doubted, however. The following are

important facts in regard to the spread of the poison and the production of epidemics like those which from time to time have caused such terrible suffering and loss of life in the Southern States.

Cause.

There is no question that the poison is *portable;* that is to say, that it may be carried from infected to uninfected regions by whatever means exist of transportation. The most frequent cause of epidemics in the United States has been the entrance into one of the Gulf ports of a vessel having the disease on board. Curiously enough, it does not seem to be a directly *communicable* disorder. It does not spread from person to person, but from place to place. In the case of ships, it is the *vessel* or her *cargo* which are the real carriers of infection; and this infection is transmitted to the *soil or something in the place where a landing is made.* In fact, yellow fever resembles the malarial diseases in every respect far more than it does the contagious diseases. In time of yellow-fever epidemic one is in no more danger if in the closest kind of contact with a patient than one would be anywhere in an infected region. In this it resembles malarial fever, and not at all scarlet fever, measles, smallpox, typhus fever, or other contagious disease, for in such diseases the danger lies in coming into the immediate neighbourhood of the sick person, or of something which has been in close proximity to him. It resembles typhoid fever, cholera, or other non-contagious, communicable disease in that these also infect indirectly; but these do not ever infect the *air*, as do malaria and yellow fever. It differs from malaria in that the latter is never transported by human agencies.

The fever is endemic in a number of tropical countries, and is carried from them, in the manner stated, to cooler regions. In no case does the poison seem to survive long when the temperature falls below the freezing point of water, and a sharp frost checks an epidemic immediately. Unlike malaria, one attack of this fever usually protects from subsequent ones; but, as in the case of malaria, it is more likely to attack unacclimated people than acclimated. The negro race is far less susceptible to it than the white.

Symptoms.

The onset of yellow fever is usually abrupt, with a chill, intense pain in the back and loins, sharp rise of temperature (103° to 105°, or higher, reaching occasionally 108° or 109° Fahr.), headache, restlessness, great prostration, and often nausea and vomiting. The pulse is more frequent than normal, and may be weak or strong.

In a few hours, or perhaps not before two or three days have elapsed, the temperature falls rapidly, and the patient improves in many ways, but remains feeble. The pulse is now slower than normal and often weak. The case may now go on steadily to recovery, or vomiting may

become a marked feature, and the vomited matters be like coffee grounds in appearance. This is the so-called "black vomit," and is a symptom of grave danger. The urine in these cases is usually diminished in quantity, loaded with albumin, bloody, and contains bile pigment. Within two or three days after the onset the patient usually becomes more or less jaundiced—hence the name *yellow* fever.

Some cases occur in which the first symptom is the black vomit, and death follows in a few hours. Death may occur at any stage in other cases.

Lesions.

The liver is found to be in a state of fatty degeneration. The kidneys are acutely inflamed. The spleen is *not* enlarged. There is jaundice in cases that have lasted long enough. Hæmorrhages in various parts of the body are common.

Treatment.

There is no specific treatment, and none that seems very satisfactory. Most authorities seem to rely much on calomel, especially in the earliest stage. Sedatives, stimulants, and various other classes of drugs may be required, according to the symptoms arising in each particular case.

CHAPTER IX.

VACCINATION.

Definition.

VACCINATION is the deliberate inducing of a specific infectious disease—*vaccinia.* The virus of this eruptive disease of the cow is inoculated into man, producing a local pock; this is followed by constitutional disturbance—that is, by fever, malaise, pains in the bones, general aching, etc. Inoculated subjects who "take"—that is, develop a characteristic pock and pass through the stages of fever—are more or less permanently protected thereafter from smallpox. A slight, acute, infectious disease (cowpox) is deliberately cultivated in the person to protect him from a severe one (smallpox).

History.

Sir Edward Jenner, 1798, as the result of observation upon dairymen and of experimentation, announced that persons accidentally inoculated with cowpox were thereafter insusceptible to smallpox. In America, as the last step in this logical progression, the law requires that, for the protection of the community, all persons be vaccinated. The virus of cowpox used in human inoculation is obtained directly from the pock (vesicle) produced upon the udder of a healthy heifer by previous animal-to-animal inoculation. When the vesicle is fullest of clear serum (watery in appearance) the chosen vehicle, either a

quill or an ivory point, is wet in the vesicle contents and allowed to dry, and subsequently kept in a cool and dark place till required for use.

Method of Vaccination.

The selected point of operation is usually upon the outer aspect of the arm, just below the attachment of the muscle which caps the shoulder joint—namely, at a point where several muscles meet in their attachment to the bone, but where there is least muscular movement beneath the skin, and consequently least pain to the developing pock. At present it is thought better practice to vaccinate on the leg, either the inner or outer aspect, just below the knee and near the shin bone.

The skin is first cleaned with soap and warm water, wiped dry with perfectly clean (boiled) cotton cloth; the outer scarf-skin is scraped away with clean new needles or an aseptic (boiled) knife. By this process there will be produced a moist, watery (serum) surface, with a little oozing of blood. This should be sufficient to dissolve the dried virus from the end of the quill during rubbing, prolonged for a minute. As the virus is rather a thick, tenacious substance, it is well to let a drop of clear water soften the virus while the preparations and operation are proceeding. The best absorbent surface is thought to be a denuded skin surface moistened with serum. A blister produces such a surface. Too much blood, by coagulation, entangles the virus in the clot, if, by its free flow, it has not already washed it away.

Successful inoculation begins to show, if the first vaccination (primary), at the end of thirty-six to forty-eight hours, a slight redness, followed by induration, burning and itching, fever, and aching of the bones. About the fifth day the inoculation wound is surrounded with a raised, ring-shaped vesicle (water blister). The fluid of this gradually changes from clear serum to opaque white, then yellow (from the accumulation of pus cells). Meantime the areola about the pock has spread to the size of a silver dollar; the skin is hot, hard, and red; little papillæ—pinhead-sized elevations—appear in the halo.

The fever, restlessness, aching of the bones, headache, and general misery form the best possible example of the "constitutional disturbance" or "febrile reaction" of a system struggling with the absorbed poison of an acute infectious disease. Infants between three months and the age of the appearance of the teeth appear to suffer less than at other ages. If the vaccination is upon the arm, the lymph nodes (glands) under the arms are regularly enlarged and tender; the arm feels heavy and painful. If the pock is developed upon the leg, the nodes of the groin will be enlarged and painful.

A revaccination does not run quite the typical course of a primary. The period of incubation will be about three days; the development of the induration, vesicle, and pustule another three days; drying and falling of

the crust a third three days; and the scar left at last much less deep and pitted than the primary scar upon the same individual.

What constitutes a successful vaccination? How long does a successful vaccination render an individual immune (insusceptible)? Upon this hangs the further question, How often should persons be vaccinated?

First, what constitutes a successful vaccination, or, more especially, a revaccination? The development of a characteristic pock with constitutional reaction. The characteristic pock has successively these stages: hardness (papule), vesicle, pustule, scab, and scar. A small, nodular, warty, red mass, or any abortive blister, does not fill out the requirements of a successful pock. Quite as characteristic, also, are the constitutional reaction fever and malaise.

Time for Vaccination in Infants.

The time for vaccination in infants is from the third to the sixth month for the primary, from the tenth to the fifteenth year for revaccination. The infant may be vaccinated at any time when it is in perfect health. It is well to wait till the third month, when its digestion is in good condition; to avoid the time of teething; to avoid any temporary depression from bronchitis or other ailment. It is thought by some that vaccinia in some way determines a favourable course when induced in patients suffering from whooping cough.

Revaccination.

How often should persons be vaccinated? A very good regulation is, in all cases, to revaccinate every five years, and at any time that an epidemic prevails. Vaccinia affords a sure protection against smallpox for a time. The duration of this immunity differs in individuals, and can not be determined. It is well to revaccinate several times, where persons are exposed to the contagion of smallpox, if the first attempts fail.

Complications.

Complications are seldom met where vaccination includes these factors: good animal virus, a healthy person, ordinary cleanliness of skin and instruments, no injury to and consequently no chance outside infection to the pock. There is now but little arm-to-arm vaccination practised, and consequently little danger of transmission of disease. There may be in severe vaccinia a certain amount of diffuse redness of the skin, with heat and tenderness, especially in the region of the pock. This may be a simple inflammation—dermatitis—and have no relation to erysipelas. There frequently is a faint diffuse or punctate eruption widely distributed over the body of a child with primary vaccination. This may resemble "scarlet rash," or may resemble measles, and yet be without significance.

The pock should be protected from injury by any simple means. A disk two inches in diameter, cut from a visiting card, may be shaped into a shallow cone, like a watch crystal, by clipping out a V-shaped segment

and bringing the edges together with rubber adhesive plaster. The plaster serves not only to lift the middle of the disk up into a cone, but the long ends serve to bind the hollow cone to the arm. Wire screens are sold in the stores for this purpose.

Practically there is nothing to be feared from the effects of vaccination. There is no reason for withholding its protective influence from an infant that is ordinarily well, and there is great injustice in attributing to vaccination any and all the ills that may overtake the patient, young or old, in the next five years of life.

CHAPTER X.

SMALLPOX (VARIOLA).

Nature and Characteristics.

SMALLPOX is an acute infectious disease, characterized by a skin eruption which passes through successive phases of papules (small, indurated nodules), vesicles (water blisters), pustules (pus blisters), crusts, scars ("pits"). It is one of the most contagious of diseases—quite as much so as measles. The nature of the infection is unknown. It is communicated by contact, by the breath, by secretions carried by third persons, by fabrics, soiled linen, utensils, etc. A corpse can communicate the infection. Crusts (scabs) are believed to be very efficient carriers of the disease.

All ages are susceptible; a child may be born with it. Other infectious diseases seem temporarily to protect against smallpox, and one attack of smallpox protects against further similar infection. Mexicans, Indians, and negroes are especially susceptible to smallpox.

The Course of the Disease.

The incubation of smallpox is from ten to fourteen days. The onset of the disease is abrupt, explosive. There is a chill with shivering, "chattering" teeth in adults, convulsions in children, high fever, headache, and, what is most characteristic, "splitting," "breaking" pains in the back (loins). There is high fever, dry tongue, stupor, or wakefulness and delirium. A peculiar preliminary eruption, resembling scarlet fever or measles, often occurs before the regular eruption. This is transient, but often temporarily misleading.

On the third or fourth day the characteristic eruption begins—three or four small pinhead-sized nodules, red and hard (papules). These are characteristically hard, deep under the skin, feeling like birdshot, which in a favourable location, overlying a bone, as on the forehead, can be rolled about under the finger. This is denominated a "shotty feel," and is

characteristic. The papular stage lasts about three days, during which time the eruption advances from the mouth, face, and scalp to the neck, trunk, and extremities, appearing finally upon the palms and soles.

The lesion (injury, morbid change) in the skin will give one the impression that it is deep; it is the true skin, beneath the outer scarf-skin, that is affected. In chicken pox the scarf-skin rises up and forms a blister-like pock; it is obviously superficial, and is surrounded by the faintest, most delicate pinkish halo. Smallpox attacks a deeper tissue, gives a "shotty" nodule, and later develops a red halo about it, which is manifestly a more serious inflammation. If the spots are close together, they later flow together, and form *confluent smallpox,* with the worst form of pitting.

The recognition of smallpox depends upon these points of history and physical signs: an epidemic or exposure, sudden attack, chill, fever, "tearing" pain in the back; later, characteristic papular (nodular) eruption, passing, in from twenty-four to forty-eight hours, into the vesicular and later the pustular stage.

The Outlook.

The outlook (prognosis) in a given case depends upon the severity of the skin eruption, the systemic poisoning, and the patient's strength to resist. Confluent smallpox is of course a serious lesion, and often fatal. This disease has the reputation which it deserves. It is loathsome and defacing; furthermore, it is a disease which is a shameful disgrace to a family. It is a monument of negligence on the part of some one. *Smallpox is an avoidable disease.* It is not, however, an exceedingly fatal disease. The writer of this paper has seen nurses and doctors caring for smallpox patients in rows in a big ward, themselves perfectly protected by vaccination. It is the duty of every parent to see that his children are vaccinated as babies, a few years later, and every time there is an epidemic or chance exposure. A recent successful vaccination is a sure preventive of smallpox. The length of immunity conferred by a successful vaccination varies in individuals. Therefore the rule is a good one to revaccinate every five years anyway, and whenever there is exposure or an epidemic.

Quarantine.

A smallpox patient should not be allowed at large until the scars have finished scaling—some three weeks or more. There exists for some time a distinct stain upon the scars of the healed pocks which remains some weeks, but gradually fades. This stage does not threaten any danger to the public, provided the mucous membranes and the skin are healed of the characteristic lesion. On releasing a patient from the quarantine, the greatest care should be taken that the skin and scalp are thoroughly cleansed with strong soap and hot water, and that no scales or crusts remain. Of course, the patient should put on fresh, new clothing. Often the palms will retain what the patients

call "seeds"—small, deep, hard crusts. Until all the characteristic morbid processes are healed, the patient should remain in strict quarantine.

Treatment.

The treatment of smallpox has been but little encouraging. Nothing is known that can hinder the formation of this deep-seated nodule and its subsequent going on to a destruction of the skin and consequent scar.

Varioloid.

This name designates the modified smallpox as it occurs in persons who have been vaccinated. The fever is milder, the eruption scanty, the course short, and rarely scars remain. This modified disease may occur in persons vaccinated in childhood, and not again. A recent successful vaccination protects absolutely. A childhood vaccination allows in an adult a varioloid. An unvaccinated person is susceptible to the one disease which shares with measles the reputation of being the most contagious of the severer domestic diseases.

The result in smallpox is from twenty-five to thirty-five per cent. of deaths. Those recovering have the mortification of knowing that their defacement might have been prevented.

CHAPTER XI.

SCARLET FEVER (SCARLATINA).

Nature and Characteristics.

Scarlet fever is an acute infectious disease (the nature of the infection unknown), self-limited, characterized by a diffuse or finely punctate scarlet eruption upon the mucous membrane of the throat, upon the skin of the neck, trunk, limbs, and extremities. There is a circumscribed bright-red flush of the cheeks, sometimes of a rather different red from the other skin surfaces, and pale areas along the nose and upper lip.

The poison finds expression early in an eruption upon the mucous membrane, seen best upon the soft palate and walls of the throat. This is important in recognising the disease, because it is nearly always present in well-marked cases, and is found early—often before any skin eruption. The skin eruption is first seen upon the neck, cheeks, chest, abdomen, and back, thence spreading upon the limbs and feet. The colour is scarlet. The eruption is either a continuous red or, beginning as fine scarlet points, becomes diffuse. The diffuse redness can be best recognised by pressing the whole hand upon the skin and quickly removing it, when for an instant the print of the hand will show white in contrast with the surrounding scarlet flush. The eyes are bright, not sensitive to light, not congested, not tearful. There is not the cold-in-the-head look, nor the gen-

[illegible]

[illegible] persons [illegible] the [illegible] modified [illegible] childhood. [illegible] A [illegible] vaccinated [illegible] the [illegible] diseases. [illegible] per cent. of [illegible] knowing that their [illegible]

[illegible]

[illegible] the nature of the infec- [illegible] diffuse or finely punctate [illegible] the [illegible]

TYPICAL CASE OF SCARLET FEVER.

TYPICAL CASE OF MEASLES.

eral swollen, "boiled" look of measles. The tongue is coated early, later clearing, and bright red on the edges and tip, with enlarged papillæ (less than pinhead-sized). In typical cases it becomes the "strawberry" tongue or "cat" tongue. The tongue may many times look decidedly strawberry-like.

Symptoms.

Symptoms which patients complain of are headache, sore throat, chilliness, or vomiting, followed by fever. In infants and young children vomiting, sudden and unaccountable, is often the first symptom. A child may vomit at the table, or suddenly vomit while playing quietly with its toys. The vomiting may be but once or several times. The poison seems to find expression in an explosion or quick overwhelming of the system with fever reaction.

From the vomiting to the first eruption on the neck is usually about one day; to full eruption, reaching the extremities, about two more days; to fading and beginning disappearance, about three more. In a general way, the history of the behaviour of the eruption of typical scarlet fever conforms to the old rhyme—

> "One to begin, two to show,
> Three to make ready, and four to go."

The fading and disappearance of the eruption follows the order of its appearance—throat, neck with the cheek flush, chest, abdomen, back, legs, and, last of all, the feet and hands.

Peeling, or desquamation, is proportionate to the degree of the intensity of the skin inflammation. In mild cases, in delicate skins, there may be very little scaling. In severe skin inflammation the outer skin may seem to be dead, parchment-like, and come off in sheets, especially from the soles and palms. The nurse should sweep the plentiful scales from the surface of the bed with a broom-brush, catching them in a dust-pan. Again, the fingers may part with their dead skin, looking like a glove-finger. The period of desquamation may begin early, and continue till three weeks have elapsed from the fading of the eruption.

The fever of scarlet fever begins abruptly with the vomiting, increases till the eruption is over the whole skin surface, then gradually declines in four or five days to normal.

The kidneys are so commonly involved, to a greater or less extent in scarlet fever, that some writers believe the eruption to be within them quite as much as upon the throat or skin. Certain it is that albumin appears (on boiling) in the urine during the early febrile stage, due probably to the poison in the system and to the fever. This usually disappears for a time in any case, and may reappear later about three weeks from the beginning of the disease. This time it has more significance and means a complicating inflammation of the kidneys. This may vary

from short, mild kidney inflammation to any severe form of Bright's disease, so called.

The nature of the skin and mucous-membrane lesion (injury or morbid change) is mostly a congestion, a local dilatation of the smallest blood-vessels (capillaries) of the skin. This implies that there is little or no infiltration, no hardness, thickness, and elevation of the surface. By gently drawing the finger along the skin the blood is displaced temporarily, leaving the skin white. Stretching the skin between two fingers blanches the congested surface and constitutes a delicate test, although no better than the imprint of the whole hand and its quick removal. The lesion, then—the real morbid change, so far as it is understood—is the expression of the general poison of scarlet fever upon the skin and membranes. An example of an infiltration or induration would be a small so-called "blind boil" or red, hard pimple.

Treatment.

The conduct of a case of scarlet fever is based on these facts: that it is an acute fever which must run a course, is self-limited, tends to a favourable ending, but is subject to certain complications which may leave certain after-results. First of all, the patient should be placed on fluid diet, milk preferred. During the first stage of high fever, with dry, burning skin, and great restlessness, there is no harm in sponging with tepid water—in fact, with any comforting treatment which common sense may dictate. It is not necessary to crowd on the bedclothing, to give hot drinks, to increase the body heat in any way, with the idea of keeping the rash from "striking in." A scarlatina patient in the first fever can scarcely catch cold in any exposure. It is not perilous even to transport one from house to hospital, as is frequently done in New York. The fever with dry skin protects the patient from the danger of catching cold so long as the fever is at its height. Indeed, it is good modern practice, where a child is hot, restless, tending to delirium or convulsions, to cool it in a bath. The irritation of a dry, burning skin causes nervousness, restlessness, and sleeplessness, which tends to exhaustion. The indications are to relieve this by simple means. Nothing is so simple, so rational, and successful as bathing. Every form of bath does good. The first bath, which should be given under the physician's directions and observation, may range anywhere from a tepid sponging to a cold full-length bath, as seems indicated.

It is our practice to cool the patient by baths—the method, the temperature, and other details to be decided upon according to the requirements in the given case.

When the fever begins to subside, the indications are to keep the patient in bed, protected from currents of air, but not to exclude fresh air. A patient does not catch cold from air that touches only the face

and enters the nose. The room should be large, airy, well lighted, with sunny exposure. All hangings and carpets should be removed and quarantine established. See regulations in *Diphtheria.*

During the scaling period the skin should be sponged frequently to remove the outer skin as it loosens; vaseline, lanolin, mutton tallow, or beef suet should be rubbed over the cleansed surfaces to limit the distribution of the scales subsequently detaching themselves.

As the dangers of kidney complications and other sequelæ of this disease are not all past before the end of three full weeks from the disappearance of the eruption, the patient should be confined to the bed during that time, especially in winter. This may seem rather arbitrary, but a child once allowed to get down on the floor is beyond control, and will certainly expose itself near a cold window or before an opened door. If in summer, the temperature is everywhere the same, and this regulation is less important. An active child may be fully dressed and allowed to play upon the bed, not getting down to the floor.

When the fever is off and the depression of the system is on, the child may easily catch cold and develop kidney trouble.

The complications of sore throat in the first week, of ear trouble, of kidney inflammation, require careful daily attendance on the part of a physician, and are not to be considered in this work. It is only to be mentioned that all foul, discharging mucous surfaces are to be kept clean and draining freely.

Outlook.

The outlook of a given scarlet-fever case depends mostly upon the complications. In the first three or five days the general poison of the disease may be a menace; a serious form of sore throat, pseudo-diphtheritic, may add itself to the characteristic sore throat of scarlet fever, and at last the kidney inflammation may cause serious alarm. However, the outlook is in general favourable, and most cases give no occasion for serious apprehension.

CHAPTER XII.

CHICKEN POX (VARICELLA).

Definition.

Chicken pox is an acute infectious, contagious disease of childhood, characterized by an eruption of vesicles (water blisters) on the skin; there are a few spots of eruption, usually upon the mucous membrane of the mouth. Chicken pox may occur in adults, notably upon those in close attendance upon a patient; parents and nurses, therefore, are often attacked. The nature of the contagion is un-

known. The virus may be communicated directly, and may be carried by a third person.

Symptoms.

The period from the time of exposure to the beginning of the first symptoms (incubation) is ten to fifteen days. The first symptoms may attract no attention unless the attack is expected. The child may be a little feverish, possibly chilly, with pains in the back and legs. Occasionally there is a slight transient rash, resembling scarlet fever or measles. Usually the first recognised signs are a few vesicles appearing upon the trunk, face, and limbs, to the number of a hundred, more or less; there may be a few in the mouth, seen best on the soft palate. The typical well-formed vesicles are glassy, or opaque white, containing a clear, watery fluid (serum), hemispherical or flattened, and surrounded by a narrow, delicate red halo, the rest of the skin being of normal colour. After thirty-six to forty-eight hours the glassy hemispheres become yellowish, begin to dry in the centre, causing a central depression, and at length become brown, dry crusts, which in a few days detach themselves, leaving a red surface. A few in each case, especially if irritated, extend deep enough to involve the true skin beneath the scarf skin, and consequently leave, on healing, a permanent scar. Usually one or more such irritated pocks occur upon the face.

When examining a case of well-developed chicken pox, it will be observed that there are present various forms of eruption or successive stages of the same eruption; upon the same back or chest there are small pinhead, raised red spots (papules); while in the vicinity can be found glassy vesicles, opaque vesicles drying in the centre, crusts, and possibly traces of fallen crusts or scabs. In short, the pock of chicken pox may be observed in every stage of its development within a hand's space. It is seen that the eruption *comes in successive crops*. This is a characteristic, which is of great aid in diagnosticating chicken pox from smallpox.

In adults the beginning of chicken pox is more severe than in children. In the general course of the disease the patient is quite miserable, but if the eruption can be found to exhibit all stages of the eruption at the same time, the diagnosis is sure.

Chicken pox is to be quarantined, but requires little care beyond rest in bed, milk diet, and time.

CHAPTER XIII.

MEASLES (RUBEOLA).

Nature and Characteristics.

Measles is a highly contagious disease running an acute, self-limited course, characterized in an early stage by symptoms of acute cold in the head, and afterward by a rapidly spreading general eruption. The nature of the infection of measles is unknown. No germ has been isolated. The contagion is communicated by the breath, by secretions of the nose and throat, and may be carried by third persons. The intensely contagious nature of measles, the fact that the early sneezing and coughing may communicate the disease before it is recognised by the eruption, accounts in part for the manner in which measles prevails in schools and communities.

Measles is a disease of childhood, but adults unprotected by previous attack and brought into close contact with a patient suffering from the measles are very liable to infection. Infants under six months are less susceptible. Both sexes are equally susceptible to the disease.

Measles occurs in all seasons, rather more in cold weather; it may occur epidemically, and may be associated with an epidemic of whooping cough. One pronounced, unmistakable attack of measles is, however, seldom followed by a similar attack of the disease, although cases of three or four recurrent attacks have been recorded.

Measles may be considered an infectious disease which finds expression in an eruption, and in symptoms associated with that eruption, the eruption visiting first the nasal mucous membrane and eyes (sneezing and weeping), and extending down into the throat or pharynx, where it can easily be seen on the soft palate and side walls, thence into the vocal apparatus, the larynx (coughing), and into the windpipe (coughing). There is a tendency to pass still farther down into the bronchial tubes. After the eruption (for such it really is, somewhat modified because it occurs now upon a mucous membrane) has traversed the respiratory ways—nose, mouth, and larynx—it begins to appear upon the forehead at the margins of the hair, behind the ears, and upon the neck. Thence it spreads upon the face, neck, trunk, limbs, and extremities, including palms and soles.

Appearance of the Eruption.

The mucous membrane of the nose is intensely red and swollen, and shows what any one would naturally designate an irritated condition (sneezing and sense of fulness). Upon the soft palate the eruption may be seen often as a spotted redness, or "stippled" red. Upon the skin the characteristic eruption first seen consists of delicate red spots, varying in size from a pinhead to two or three pinheads, separated mostly by normal skin, though show-

ing a tendency to group into patches which the fancy of the authors has usually considered crescentic. The colour of the spots is delicate red when first seen upon the protected skin behind the ear. There is a slight tinge of purple in the thickly grouped patches, and especially upon the cheeks. The eruption is best observed upon the trunk when the patient is warm in bed. The eruption may be scattered, patchy, or diffuse.

Symptoms.

The characteristic symptoms of measles develop in the order of the progression of the eruption—namely, sneezing and weeping, bloodshot eyes, cough, and skin eruption on hair margins, face and neck, trunk, limbs, and extremities. From the time of the first cold in the head to the first eruption is usually three full days. From the first eruption on the face to the full eruption on the body and extremities is usually twenty-four hours. The eruption is at its height in about twenty-four to forty-eight hours longer.

The fever is now to be mentioned. It begins at the outbreak of the disease with the nose and eye symptoms (cold in the head), continues during the skin eruption on the face, and quickly mounts to a considerable height during the development of the eruption over the large skin surface. In other words, the "breaking out" of the disease gives rise to a local lesion (injury) which is attended with a fever somewhat proportional to the extent of the lesion, first upon the mucous membrane, then upon more and more extended skin surface. The skin is inflamed, thickened and congested. It is to a variable extent hot, itching, and burning. The patient reacts with a fever proportionately, and when the acute "breaking-out" stage is past, the fever quickly subsides. This is a favourable course.

Complications.

Though measles is usually a mild disease and without complications, yet in large institutions for children, or among soldiers in barracks, or inmates of workhouses—wherever people are crowded—measles may be attended with more or less serious after-effects. The eruption which has progressed from nose to larynx may descend the windpipe into the bronchial tubes and produce bronchitis or broncho-pneumonia. The inflammation of the nasal mucous membrane may mount through the little tube leading to the middle ear and cause an inflammation, with pain and possible abscess, drum perforation, and discharge. This is not, however, frequent. The one complication to be feared is severe lung trouble tending to pneumonia.

Treatment.

Measles is an acute, self-limited disease. Mild, uncomplicated cases require only protection, that Nature may have a fair fight; rest in bed, to secure protection from exposure and fatigue; fluid diet, because it is more easily assimilated by a patient with fever and without the usual exercise of health; a mild purgative, to place the organs in a condition of unembarrassed facility for elimination and absorption.

No one but a skilled physician can assume the responsibility of saying a case is typical, running a mild course, with no fear of complications. If the child is under one year, measles is not a trifle; the danger of pulmonary complications requires the care of an expert. If over two years old, the child may be said to be comparatively better able to bear the attack.

Concerning the dark room in the stage of weeping—the initial stage—it is not wise to overdo a good practice. The eyes should be directed away from a bright light or bright reflection for the first four days. If the light causes pain and irritation, protect them; but do not depress the patient in prison darkness. As for keeping the patient warm, it seems useless to say anything. Most anxious friends satisfy a traditional demand by swathing the child and keeping the skin macerated in perspiration. It is a consolation to the friends, and the patient usually survives this excess. *It is not necessary to go beyond the bounds of comfort.* If a child's skin is warm, it shows redder; if the air comes to it, the redness pales a little from contraction of the capillary vessels in the skin. It is, however, difficult to conceive of an acute infectious disease in a fevered patient requiring this added heating and macerating of the skin. When the cold strikes the skin and the redness pales a little, let it be remembered the effect is not necessarily a "striking in" of the eruption. This last condition, "striking in," having so much traditional value in the minds of the laity, has really much the same physiological significance as the pallor or the rattle in the throat of a dying patient. It is, in other words, akin to collapse or fainting, coincident with failing heart and approaching dissolution. It can not be brought about by temporary exposure; therefore do not add to a fever patient's misery by still further heating the tissues. As a general precaution protect a moist, fevered skin from draughts; a dry one is less susceptible.

To recapitulate: Protect the measles patient, that Nature may make a good fight. Protect the eyes while they are irritable from the irritation of light. Protect the intestine from absorbing food that is not digested because of high body temperature, or from its being of an improper quality. Protect from draughts; protect from the effect of traditions which lead to shutting out fresh air; and protect from macerating the patient. Finally, remember that the so-called "striking in" of an eruption is a serious feature, because it is associated with grave internal changes, but it does not arise from a momentary draught of air.

During the recovery of a patient there is a fine, branlike scaling of the skin, varying in degree. Many times a measles cough persists for weeks. It seems to be the local effect of the original eruption plus the mechanical injury of severe, prolonged coughing. It is a hard, throaty cough, and does not indicate bronchitis.

How long should a patient be quarantined after measles? The period of incubation for the infection of measles is from ten to twelve days—from the eruptive stage of one case to the eruptive stage of a succeeding case. It is not certain how late the contagion is active—how long after the eruption begins to fade. It is certain that contagion is very active from the beginning of the initial cold-in-the-head symptoms. It is desirable, therefore, to wait till the eruption and all catarrhal symptoms have disappeared before the quarantine is broken and the child allowed to mingle with others. Before its reappearance in the community the child's skin and hair should be thoroughly cleansed with warm water and strong soap, and fresh boiled or new garments put upon it. The discarded garments should be thoroughly beaten and aired, disinfected by boiling, and washed in strong soap and water. The room should be washed, the carpet and hangings beaten, and the whole aired thoroughly.

GERMAN MEASLES (RÖTHELN, RUBEOLA).

This trifling disease, a transient imitation of measles at one time and of scarlet fever at another, is so little understood by experts that it is hardly worth while to discuss it here. It may resemble measles in respect to the symptoms—eruptions upon the throat and skin—yet the conspicuous signs all fade in twenty-four or forty-eight hours, any trifling fever which it may have provoked being gone as well. Many such cases have been observed in a patient who, before or after this attack, had undoubted measles. At another time the eruption may be very like scarlet fever, transient, and unattended, with high or prolonged fever.

The diagnosis of German measles is usually made on its speedy disappearance, the eruption coming and going in the space of forty-eight hours.

This disease is contagious, and occurs often in epidemics.

CHAPTER XIV.

TYPHOID FEVER.

Origin and Nature.

Typhoid fever is an infectious disease, due to a specific bacillus, characterized by a fever of great irregularity in different cases, and with great irregularity of symptoms. Indeed, typhoid fever may be characterized as a disease without characteristics at least recognisable from bedside observation. In a thousand cases, however, something may be learned which constitutes a typical disease picture.

Typhoid prevails in the United States and Canada, appearing mostly in August, September, and October, and has been called the autumnal fever. Youth and young adult life are most susceptible to typhoid. The disease is mildly contagious, the specific contagion being found in the passages. In thinking of the contagion, let it be remembered that the bacilli act practically like microscopic burrs. They may be carried, and adhere to anything which they may touch. If these minute objects be allowed to dry upon the skin, they may become dustlike and so carried. Soiled clothing, bedding, and other fabrics serve as vehicles. The lesson is, then, *cleanliness and disinfection of stools.* In hospitals, typhoid patients are not separated from other patients, and neither nurses nor other attendants acquire the disease. Typhoid bacilli maintain their vitality after drying and freezing. Milk may become a favourable growing medium if the cans become infected from water used either in washing or otherwise.

Let it always be remembered that not all persons are susceptible to the germ, and in perfect health a person may fairly feed upon and yet resist the poison germ.

The characteristic morbid changes (lesion) of typhoid fever is swelling of a group of glands in the lower portion of the small intestine. These are denominated the *patches of Peyer*, or *Peyer's plaques.* These grouped nodules are about as wide as a finger and one to two inches long. The whole symptomatic history of typhoid fever is centred upon the behaviour of these "patches."

Approximately, the stages of the fever are these: First week, swelling of Peyer's patches; second week, loss of vitality in the substance of the gland, and death of the part (necrosis); third week, sloughing or separating of the dead tissue, forming open ulcers; fourth week, healing.

The reasons for fluid diet, even in the fourth week, appear from the above anatomical changes.

Symptoms.

The earliest symptoms of typhoid fever are general indisposition, loss of appetite, nose-bleeding. The onset of the disease is insidious; the patient takes to bed without a suspicion of what is before him. After about a week there appears upon the abdomen a rash—a few, seven, ten, or many delicate rose-coloured spots, pin-head-sized. The characteristics of the spots are the delicate rose-colour, the exceeding ease with which they become temporarily effaced, the slightest pressure or gentle traction sufficing to efface them entirely, and finally the fact that the spots come in crops. There is enlargement of the spleen and liver. The general appearance of these patients is "typhoid"—stupid, dull, apathetic. The tongue and lips are dry and brownish. The passages of typical cases are "pea-soup" in appearance—fluid, greenish, flaky. This characteristic passage is not present in a large per-

centage of cases. Though diarrhœa is frequent and a feature of the classical type in a thousand cases, yet it is not infrequent to find constipation present throughout the disease.

Outlook.

The outlook of a typhoid patient depends upon the previous habits of the person, upon the general nutrition and health before the attack, and upon the amount and virulence of the poison absorbed; or, to express it in another way, upon the way in which the patient (in the cells making up his body) is able to combat the poison in the system. As the lesion of diphtheria is practically limited to the throat, so the lesion of typhoid fever regularly is found in the lower end of the small intestine. In both cases there is a local lesion, necrosis, absorption, systemic poisoning, and febrile reaction. So the outlook may be fairly estimated by the manner in which the patient bears the reaction.

Complications.

Complications are not common, and for individuals living among well-fed communities there are not those dangers that large metropolitan hospitals report. Dependent upon the behaviour of the ulcers in the thin-walled intestine there may be hæmorrhage or perforations, with consequent peritonitis. These are rare even in large hospitals.

Treatment.

In treatment the indications are fluid diet, to allow the grouped glands (patches) to traverse the inevitable disease cycle uninjured, bathing, to keep the high temperature from injuring the heart's action and clouding the mental activity. Protect the patient from injury to the intestines due to hard food, from high temperature—giving Nature an opportunity to fight the flood of poison—and the outlook is good, even when the patient is apparently very low.

The passages should be caught in a bedpan containing carbolic-acid solution (one part of strong carbolic to nineteen or twenty parts water) or other disinfectant, allowed to stand an hour to fully destroy the germs, then disposed of, that no surviving germs may drain into the supply of drinking water. The parts of the patient should be cleansed; all soiled linen should be boiled and otherwise disinfected, according to the ideas of the physician. Strong soap and hot water is a solution of unappreciated value as a sure disinfectant.

CHAPTER XV.

WHOOPING COUGH (PERTUSSIS).

Nature.

Whooping cough is characterized by a spasmodic cough, ending with a long-drawn, crowing inspiration, denominated a "whoop." It is a highly contagious affection, occurring in epidemics, the nature of the infection being still unknown. It is conveyed by the breath, expectoration, atmosphere, and fabrics. Children between the first and second teething are most susceptible, though parents and nurses, and other adults in intimate relations with the patient, may acquire the disease.

Symptoms.

From the time of exposure to first symptoms (incubation) is seven to ten days. The first symptoms are those of any ordinary cold—fever, cold in the head, bronchial cough—the cough becoming spasmodic. A prolonged bronchitis, with a cough tending to come in paroxysms, is suspicious, especially if an epidemic is prevailing. After ten days of the above symptoms a whoop is heard, unmistakable if well marked. The paroxysm usually can be anticipated by the little patient. A look of anxiety comes over the face, the child ceases its play, clings to its mother's skirts, and awaits the coming storm. The paroxysm seizes the child, puts it to prolonged, urgent efforts at coughing, till its breath is exhausted, its colour dusky, perspiration beads its forehead, and it has expectorated a teaspoonful of thick, glairy mucus, or has vomited. Then the spasm relaxes, the child draws a long inspiratory "whoop," and sinks exhausted to rest. The intervals usually allow time for rest, play, sleep, and food. These spasms may occur three or four times a day or as often as every half hour. After a fortnight the attacks appear less often and die away, the bronchitis lasting a little longer.

Outlook.

The outlook (prognosis) depends on the age of the child, the amount of impairment of nutrition from cough or vomiting, and the amount of bronchitis. An infant under one year is in danger of the complications resulting from the bronchitis—namely, broncho-pneumonia. As to vomiting, it is seldom that it seriously impedes the child's recovery. The stomach, not being primarily deranged, manages to digest enough food to maintain the child's nutrition. It certainly is a striking fact that, though a child seems to vomit everything, it continues to keep its weight fairly well.

Whooping cough takes its name from the conspicuous symptoms. The nature of the infection and the lesion are unknown. Treatment is addressed to the bronchitis, to maintaining the nutrition, and to removing all causes which induce the spasm. The spasm may be induced by

irritation from a deranged stomach, or from excitement, inspired dust, crying, etc.

Treatment.

Treatment should be carefully superintended by an expert. A large room, well aired, with even temperature, is dictated by the condition of the respiratory organs. The diet of the child should be watched and regulated. There always remains the question whether to take the child into the open air, and what conditions of atmosphere forbid it. Whatever course is pursued, everybody will probably be sorry another was not chosen. Our own preference is, in older children, when the bronchitis is not deep in the finer bronchial tubes, to take them if it be possible many hours a day into a moderate, dry, outdoor atmosphere. It seems to diminish the frequency of attacks of cough, act favourably on the bronchitis, and assist in maintaining the nutrition. It requires a nice adjustment of case to seasons and to daily weather conditions, and no fixed rule can apply to a series of cases. It is possible to "go out walking" in the house. Open wide the windows of a large room, dress the child for the street, and promenade the aired room for a time. The warm walls will temper the outdoor air and the child will receive some good from the fresh-air promenade.

CHAPTER XVI.

MUMPS (PAROTITIS).

Nature.

Mumps is an infectious disease, characterized by an acute inflammation of the parotid glands. The parotid glands are irregular, sock-shaped glands, lying in front of and below the ear (see *The Anatomy of the Human Body*, Fig. 48). The nature of the infection is unknown. The disease is contagious, spreading from patient to patient, occurring more often in epidemics. Children and youths are most susceptible, infants and adults least.

Symptoms.

The time elapsing from exposure to the first symptoms of the disease (incubation) is two or three weeks, usually in this time no intimation being given of what is to develop. The first symptoms are fever, pain below the ear on one side, swelling which outlines the parotid gland, followed by a diffuse swelling of the neck and cheek. After one or two days the opposite side begins the same cycle of pain and swelling. When the swelling is at its height the patient experiences much pain and difficulty in separating the jaws. Swallowing and speech are painful. The time-honoured method of testing the oncoming disease—tasting a pickle or other savoury food—depends upon the fact

that such flavours stimulate the gland to functional activity, to pour out its secretion. Besides pain on movement there may be a constant feeling of tension, more or less earache, and temporary deafness. Drooling of saliva may be a feature.

Complications and Outlook.

After a course lasting a week or thereabouts, the swelling subsides and the patient recovers, with reasonable assurance of immunity from another attack. There are rarely complications. In the male, after puberty, one testicle, more often the right, may become inflamed, painful, and swollen, much in the same manner as the parotid gland. In the female the genitals and vagina may have a catarrhal inflammation, with yellowish discharge; the breast may become enlarged and tender; very rarely, one ovary. These are rare complications, and are due more to the original infection, probably, than to catching cold.

The outlook of the original disease and any of the rare complications is good. The patient usually recovers completely.

Diagnosis and Treatment.

The identification of mumps in children is easy. The sock-shaped swelling before and below one ear, with fever, pain on motion of the jaw, and a history of exposure to the contagion, makes the diagnosis clear. Rarely the parotid gland becomes inflamed in the course of infectious disease in adults, but that is quite another affair.

In treatment the main object is to make the patient comfortable. The disease is self-limited and seldom gives rise to alarming symptoms.

CHAPTER XVII.

DIPHTHERIA.

Origin, Nature, and Characteristics.

Diphtheria is an acute infectious disease, due to a specific germ, and characterized by an inflammation of the mucous membrane of the nose, mouth, or other air passages, the peculiar feature of the inflammation being the production in and upon the mucous membrane of a so-called "false membrane." This constitutes the local diphtheria. The constitutional effect and symptoms depend upon the absorption of poison. This characteristic false membrane is of ash-gray colour, found at first more commonly upon the tonsils, from which it spreads to adjacent surfaces, notably the soft palate. From this beginning it may spread upon continuous mucous surfaces to the nose, or downward to the larynx and lungs. The false membrane reminds one somewhat of the effect of a drop of water upon a fresh white

blotting paper. There is a swelling of the tissue, circumscribed, surrounded by the original tissue. The false membrane is not simply formed upon the mucous membrane, but is a part of it, thickened, changed, and circumscribed. The mucous membrane surrounding the patch of false membrane is regularly inflamed.

The bacillus of diphtheria, named from the two investigators to whom we are indebted for the discovery and completed study, is the Klebs-Loeffler bacillus. It is a microscopic organism of one cell, rather larger than the bacillus of consumption, irregularly "clubbed" or rounded at the ends. It multiplies by dividing itself in the middle, the two ends becoming two mature forms, and dividing again into two, and so on.

Like many other disease-producing organisms, they are probably present in abundance in crowded populations, and temporarily in the throats of many healthy persons. So long as such a person remains "insusceptible" the organism either continues to exist, doing no harm, or dies out, not finding suitable soil in which to grow (see *Bacteria*).

If a child previously insusceptible has in its throat the bacillus of diphtheria and by some accident, such as catching cold, the development of scarlet fever, or by some other cause, becomes susceptible, what occurs? In other words, what is the history of a case of diphtheria in a general way, so far as we know it?

History.

The history is in general, this: A child whose throat for some reason has the conditions favourable to the growth of the specific germ of diphtheria—that is, becomes susceptible—acquires the micro-organism. The tonsil is more often the seat of the first lesion (injury or morbid condition). It would appear that crypts and cavities of these bodies form a good culture medium. The germ, finding a favourable soil, grows and multiplies. In some way connected with its growth there is developed a soluble poison, a so-called toxin, which causes circumscribed death (necrosis) of the cells making up the membrane covering the tonsils. It is as though a tramp should build a fire upon a lawn, killing the grass in a circumscribed area, charring the roots and sod. The false membrane is then a circumscribed death of a mucous membrane—a necrosis—the result of the peculiar inflammation set up in a susceptible patient's throat by the presence and growth of the bacillus of diphtheria. This dead membrane is augmented by coagulated fluid from the blood and the white cells from the blood. The tendency of the false membrane is first to cover the entire surface of both tonsils. There it stops as at a natural barrier. It may, however, spread to the nose, involving all the mucous surfaces of the nose and throat, and halt again at a seeming second barrier, the larynx. It may finally pass this point and find free passage to the lungs. The laryngeal invasion constitutes the worst variety of diphtheria, and is known as "membranous croup."

The bacilli of diphtheria are practically found only in and about the false membrane, not within the organs of the body. The poison there elaborated by the growth of the germs is absorbed into the general circulation and gives rise to the systemic disturbance (fever). It is obvious, then, that treatment must comprise local and constitutional remedies.

Symptoms.

The general symptoms of diphtheria are frequently disproportionate to the amount of false membrane seen in the throat. There may be but little fever in diphtheria, beginning insidiously, and the child not seem very sick. The throat may feel sore or not. There may be headache or none. When it is remembered that the poison is elaborated in the false membrane and the system absorbs it, and "reacts" irregularly, it does not seem necessary to detail the fever further.

It is believed by many of the medical profession that a throat severely "sore" at the outset and accompanied by high fever is more likely to prove non-diphtheritic. The constitutional symptoms of diphtheria are exceedingly variable.

Complications.

Heart weakness is one of the early signs of severe systemic poisoning. It manifests itself in frequency and feebleness of beat. Of these qualities the inexpert can form no trustworthy opinion. Age, temporary excitement, and other factors come in to produce varying results. Late in the disease there is a form of heart weakness attended with some perils. Suffice it to say, diphtheria patients with a manifest tendency to heart weakness should, as a rule, be kept lying down, the head not unnecessarily raised from the pillow, and for some time the heart should not be excited or put to unusual strain. Pneumonia is not a frequent complication except there is false membrane in the larynx. Different epidemics display different peculiarities. Many are mild and attended with slight mortality. The kidneys are often temporarily inflamed in severe cases.

Contagion of Diphtheria.

It has been demonstrated that in all true diphtheria the specific bacillus is present. The bacillus may be dried in the mucus expectorated from a diphtheria patient, become pulverized by different means, and wafted on the air. For practical purposes it is better to think of the germ as a burr which adheres to anything it touches. A child in sneezing or coughing may spray the garment or face of an attendant with sputum containing germs. This may adhere to the fingers, be caught under the finger nail, fasten to the hairs of the beard, and thus be carried until it is caught upon another object. It is endowed with great powers of vitality, capable of being awakened to new growth and activity after months of existence in a dried state. The indication is to destroy the germ in the mouth, in the expectorations, upon whatever it may adhere to in the vicinity of the patient. Bacilli

incased in dried mucus of sputum are especially well housed for a long life. Strong soap and hot water readily dissolve this tenacious casing. Nothing could bring greater dismay to the heart of a malignant bacillus than to have its domicile destroyed, its armour stripped away, and, half flayed, to be flung into a corrosive disinfectant.

To this end the attendants should be guarded. They should keep their throats healthy and free from mucus and pus by frequent gargles, with nasal sprays, using bland fluids, such as salt or boric-acid solutions, one or two teaspoonfuls to a pint of water. This mechanically irrigates the surfaces and determines a healthy condition to the mucous membrane. *Cleanliness is nine and a half tenths of the treatment of all catarrhs.*

Treatment.

To control the wanderings of the germs the patient should be quarantined, cutting off all communication with those not necessarily attendants upon the sick. With the patient the attendants must, so far as possible, live in quarantine. On releasing from quarantine, the child should be washed thoroughly, put into clean, fresh clothing, and the infected articles left behind in the old quarters.

The room should be large, airy, and have a sunny exposure. Air should be allowed to change easily and freely without appreciable draught. All hangings, the carpet, all needless fabrics, valuable toys, and bric-à-brac should be removed at the earliest moment. At the completion of the case the walls should be stripped of paper and washed down with disinfecting solutions, or, if this is impracticable, should be wiped (the ceiling also) with fresh-bread masses, which entangle the dust and germs and serve as a vehicle for removing them to the fire.

Let it be remembered that germs like dust settle upon irregularities of wall, upon ledges, and upon the floor. To these special attention must be given. First wipe with a damp cloth all up-facing surfaces, and when the floor is cleaned it should be flooded with disinfectants in order to saturate the accumulations of dust, lint, and germs in the cracks. Once more, let it be remembered that cleanliness of the old-fashioned strong soap-and-hot-water variety is very efficient.

The woodwork—this includes bedstead and furniture—should be treated in this old-fashioned manner and thereafter washed with the disinfectant. The bedding, and all fabrics which can be so treated without ruin, should be first washed thoroughly in hot water with strong soap and afterward boiled hard for an hour or more.

Strict quarantine should be kept till the child has been pronounced well of diphtheria—at least three weeks.

CHAPTER XVIII.

MENINGITIS.

Meningitis is an inflammation of the membranes (meninges) covering the brain and spinal cord. According to its distribution and character, it is variously named cerebral or cerebro-spinal; and according to its character, tubercular or simple. The most frequent location of meningitis is upon the meninges enveloping the brain, and the more frequent variety is, in children, tubercular; in adults the variety is indeterminate.

Diagnosis.

Cerebral symptoms are common in children from nearly every ailment—indigestion, anything causing high fever, pneumonia, and finally from causes unexplainable. For the comfort of the reader it may be remembered that if an excited parent makes a diagnosis of meningitis, whatever else the child may have, in a vast majority of cases it will not have meningitis. One of the most difficult diagnoses to be sure of early in the case is the disease under consideration. Since it is the most difficult test of an expert, it need not be discussed here except to mention some of the points which may help to rule out meningitis.

First of all, an acute catarrh of the stomach and intestine, or an acute indigestion, may give every symptom that a growth of tubercles or a simple inflammation of the meninges can give—namely, vomiting, stupor, convulsions, crossed eyes, cramped hands, stiff neck, retracted head, and many more.

Symptoms and Treatment.

True meningitis is not commonly met. Among the symptoms in children, these are perhaps the most suggestive: Prolonged obstinate vomiting, which is sudden, projectile, or explosive, and not due to errors in feeding; dense stupor, with a masklike, expressionless, or deathlike countenance; bulging fontanelle—the anterior "opening" of the skull (see *The Anatomy of the Human Body*, Fig. 7); automatically repeated motions of any limb or of the eyes; a peculiar disturbance of the rhythm of respiration, which passes through this cycle, beginning with a deep sigh and followed sooner or later with a suspension of respiration for a few seconds (called Cheyne-Stokes respiration, from two writers on the subject). The bowels are constipated and the abdomen is sunken. Castor oil cures most cerebral symptoms. True meningitis is not common.

CHAPTER XIX.

RHEUMATISM.

A NUMBER of quite distinct diseases are included under the title *rheumatism.* It is unimportant for the general reader to attempt to burden the mind with too much technical detail, and a description of the differences between chronic rheumatism proper and several other chronic joint diseases which closely resemble it would be confusing and useless for our present purpose—the more useless since the only possible hope of benefiting any of them lies in the employment of specially trained professional skill. We may classify rheumatism as *acute* and *chronic,* and include a number of joint affections under the latter head.

ACUTE ARTICULAR RHEUMATISM.

Synonyms: Acute rheumatism; inflammatory rheumatism; rheumatic fever.

Acute articular rheumatism is an acute disease characterized by pain, tenderness, and swelling, with or without redness, affecting one or more joints and often affecting a number in rapid succession, and accompanied by more or less fever.

Causes.

The real cause is unknown. The common idea that it is a direct result of what is called "catching cold" is only correct to a very slight extent; exposure in wet and cold weather, or to draughts, or to any conditions which chill the body surface, is occasionally followed by an attack in *people predisposed to rheumatism;* but while a history of exposure is obtained in a few cases, in many more it is not. Moreover, among the cases ascribed to the results of exposure and "taking cold," inquiry reveals that the great majority of them must have been subjected to quite as much, if not more, exposure very many times before without bad results, and that there is really little reason to ascribe their sickness to it. People who are habitually exposed to cold and wet are more prone to rheumatism than are others. The disease is most common in the temperate zones. It is rare alike in very hot and very cold climates. It is more frequent during the colder months than the hotter. It is distinctly hereditable, frequently attacking several members of a family. It occurs at all ages, but is most common in youth and early adult life. A person who has had one attack is very apt to suffer from subsequent ones. In many cases it follows scarlet fever, and occasionally other acute infectious diseases.

The invasion is usually abrupt. Pain, rapidly becoming worse, is felt

in one or more of the larger joints (sometimes the smaller are first involved). Within a few hours the pain is intense, and the slightest movement increases it terribly; the affected joint or joints become swollen, the skin about them is tense and shiny, and usually reddened; fever is observed, the temperature being between 100° and 104° Fahr.; the pulse is increased in frequency; the appetite lost; there is restlessness and nervousness, intensified by the dread which the patient feels of moving; the skin is often bathed in profuse sweat, the odour of which is sour and offensive and the reaction very acid; the urine is diminished in amount, high-coloured, and intensely acid. The inflammation may involve only one joint, or several may be simultaneously attacked; or it may be that the inflammatory symptoms will quickly leave joints first affected to appear in others which had a few hours before been free.

Symptoms.

The sickness may last a few days or it may be prolonged several months. It is impossible to tell how long it will continue in any case. Sometimes the fever disappears, but the joints remain swollen, tender, and painful, and the case becomes chronic.

The great danger of rheumatism is that the heart may be involved, and endocarditis or pericarditis result. (See *Diseases of Digestive Organs, Heart, and Lungs.*) Other complications are rare. Occasionally—but very, very rarely—the temperature of an uncomplicated case rises rapidly to an extreme height—106° to 109°—and the patient, after being wildly delirious, becomes comatose and dies. This is called *rheumatic hyperpyrexia.*

Complications.

Complete rest in bed is imperatively demanded. The tender joints may need to be protected from the weight of the bedclothes by suitable bed racks. (See *Surgical Injuries and Surgical Diseases*, Fig. 28.) Some cases do well on doses of salicylic acid (ten grains in capsule every two hours) until there is ringing in the head. Others do best on large doses of alkalies. Anæmic patients require iron. Every case should be under the care of a physician who can recognise disease of the heart and treat it, should it arise, promptly and skilfully.

Treatment.

CHRONIC RHEUMATISM.

Chronic rheumatism may begin acutely, or it may never have had a true acute stage. When it begins acutely, the cases usually consist of a series of acute attacks following in such rapid succession that the patient has not fully recovered from one before having another.

In such cases joint after joint is more and more injured, until finally permanent changes of a destructive nature result. There is no fever except during one of the acute attacks, but the joints remain swollen and stiff, painful and tender. In time the ligaments, synovial membranes,

and even the cartilages and ends of the bones, thicken and grow rough, and new fibrous tissue forms which obliterates more or less the cavity of the joint and binds it and the surrounding structures rigidly together. The limbs are thus variously deformed, and motion of them is interfered with or rendered impossible. At the same time that the stiffening is taking place, changes in the cartilages are apt to occur which tend to dislocate the bones and throw the limbs into hideously unnatural positions. There is always more or less pain during the acuter outbreaks, and some pain is constant in bad cases, especially when effort to move a diseased limb is made. The general nutrition suffers; the limbs waste, partly because of disuse of the muscles connected with the affected joints and partly because the appetite fails and the digestion is not good. The disease may last ten to twenty-five years.

Some cases do not have the acute outbreaks; one or more joints gradually become stiff and painful, and, as time goes on, these swell and become disorganized. Among these cases are to be found a number which are not truly rheumatic at all, but which, as I have said, it is needless to attempt to describe separately in this book.

Chronic rheumatism is a disease usually met with after middle life. Some of the cases with acute beginning are found to occur in the young, and even in childhood. The prognosis is not good as to recovery, but life may not be shortened, and, under good treatment, the process may be arrested for a longer or shorter time, during which the patient enjoys freedom from pain, if nothing more.

Baths, especially hot baths, alkalies, tonics, and regulated diet free from starch and sugar, are the measures employed.

CHAPTER XX.

GOUT.

Gout is a disorder characterized by faulty metabolism, which results in the formation of an excess of uric acid in the system, and by various injurious effects produced by this substance. These are manifested sometimes in acute inflammation of joints, with a deposit about them of urate of sodium; sometimes in disease of the blood-vessels or some of the viscera; sometimes in both of these ways.

The direct cause of the lesions of gout is the presence of an abnormal amount of uric acid in the blood and tissues of the body. The excess of this acid is thought to be due to the faulty action of some of the organs concerned in metabolism, whereby uric acid is produced instead of urea.

(For description of metabolism and the formation of urea, see the article on *Physiology: The Vital Processes in Health.*) Urea is the ash of the nitrogenous food, and uric acid is thought to represent one of the changes which takes place in such food during the process of combustion. It is not so rich in oxygen as is urea, and may be looked upon as a partially burned ember. Whatever its origin, it is present in excessive amount in gouty people, and it certainly is poisonous in its effects.

Causes.

Gout is a markedly hereditable disease. In a person predisposed by heredity to it, it is almost sure to follow lack of exercise and high living, if indulged for a sufficient time. It is one of Nature's rather grim practical jokes, that she makes many of those who inherit gouty tendencies with a strong inherited liking for physical indolence and for the pleasures of the table, thereby tempting them to their destruction! Indolence, overfeeding and overdrinking—and still more, excessive indulgence in *improper* articles of diet—may cause gout even in those who have no family taint. The precise opposite is true; gout is sometimes caused by starvation and privation of various sorts.

Gout may be classified as *acute* and *chronic gout* and as *irregular* or *suppressed gout.*

ACUTE GOUT.

Acute gout begins suddenly with an intense pain in one of the joints —most frequently the metatarso-phalangeal of the great toe. The attack usually begins at night. The joint is exquisitely tender and painful; it soon swells, as does also the neighbouring tissue; the skin is tense, hot, and red; there is some fever; extreme irritability of temper (partly due to the pain, but partly also to the disease poison); scanty, high-coloured urine; coated tongue; quickened pulse. The attack soon reaches its maximum, and remains violent for from one to six or eight days. During this time there are remissions of pain; but sudden twinges, often produced by involuntary twitchings of the muscles about the joint, occur at intervals, causing great agony. As the attack subsides the pain lessens, the amount of urine secreted increases. On cooling the urine deposits abundant urates; sometimes there is diarrhœa. The tenderness and swelling of the joint remain for some time after the acuter symptoms have subsided.

Symptoms.

It is a curious fact that people who are habitually cross and unpleasant often exhibit a sweetness of disposition just after an attack of acute gout, which makes their relatives hail the outbreak with joy.

Lesions.

The tissues about the joint are found to be acutely inflamed and to contain a quantity of urate of sodium deposited in their substance.

CHRONIC GOUT.

A succession of acute attacks results in chronic gouty inflammation of the joints and the complete destruction of them by infiltration with the urates and by breaking down the tissues about, filling them with the same salts, and finally producing sluggish abscesses, whence the urates are expelled from time to time. In chronic gout almost every small joint in the body may be invaded and the patient become a hopeless invalid. Death sometimes occurs from sudden gouty inflammation of some important organ. Thus the stomach or liver may fail, or the heart be stopped.

Treatment.

Colchicum used during an acute attack almost always checks it within twenty-four hours. It is questionable whether, in the long run, this drug does not do more harm than good. It is considered wiser by many good physicians to try rather to make the patient comfortable by opiates, and let the attack run its course, than to check it. The latter course seems to tend to cause internal disturbance quite often, and complete recovery does not seem to come so soon when colchicum is used as when it is avoided. The patient should be put upon a diet of slops during the attack and for some time afterward. Between the attacks he should eat plain digestible food, avoiding all rich dishes and all sweets ; and preferably should drink no alcoholic beverage of any sort. If he *will* drink stimulants, let him avoid beer, ale, and all malt liquors, Burgundy, heavy clarets, Rhine wine, champagne, sherry, Madeira, port, and all sweet wines—in fact, the best thing for him to take is whiskey or brandy largely diluted and in small quantities.

Some do well on a diet composed almost entirely of meat, fish, and green vegetables, and as free as possible from starch and sugar. Others do best on starchy foods and fish, eschewing all red meats. Exercise, and plenty of it, is imperative, and open-air exercise is especially beneficial. The skin should be kept in order by frequent baths and daily friction.

IRREGULAR GOUT.

Gout manifests itself in the most varied forms in many people who inherit it. Chronic and acute skin diseases, dyspepsia, asthma, bronchitis, emphysema, Bright's disease, disease of the liver—these are some of the shapes in which it makes itself felt. They have been sufficiently described under their appropriate heads. The gouty forms of these diseases do not differ from those produced by other causes. In treating any of them it is necessary to remember that it may be of gouty origin, and to treat the *gout* by diet, etc., in order to benefit any manifestation of it in any particular organ.

VIII.

DISEASES OF DIGESTIVE ORGANS, HEART, AND LUNGS.

BY FRANK W. JACKSON, M. D.

CHAPTER I.

DISEASES OF THE PLEURA.

PLEURISY is an inflammation of the membrane which covers the lungs and also lines the surface of the chest wall. This membrane is known as the pleura. Its office is to cover and protect the lungs, and to facilitate the movement of the lungs as they expand and contract during respiration. The surface of the pleura covering the lungs lies opposite, but unattached, to the surface of the pleura lining the chest wall, and, as these two opposing surfaces are smooth and glossy, the lungs move over the chest wall without friction.

The Pleura.

This pleura is liable to various forms of inflammation, some of which are only part of a general inflammation involving the tissue of the lung, and some of which involve the pleura without disease of the lung. It is the latter class which I am now describing.

Simple pleurisy, or *acute pleuritis*, is an inflammation of a small portion of the pleura lining the chest wall and of the corresponding pleura upon the lung. The result of the inflammation is simply to roughen the surface of the pleura by an exudation of fibrin. It may be caused by various conditions; a severe blow upon the chest will produce it, or a fracture of a rib, or exposure to cold. Persons who are subject to rheumatism may have it. It is sometimes found associated with Bright's disease of the kidneys, and it is often found as one of the manifestations of *la grippe*.

Simple Pleurisy: Symptoms and Treatment.

The symptoms of a simple pleurisy are a certain degree of fever and general discomfort, a short dry cough, that is, without expectoration, more or less pain over a small portion of the chest, with perhaps a little shortness of breath. The pain is generally intensified on taking a long

breath. The disease usually lasts about a week, and at no time does the patient feel very sick.

A mustard poultice over the seat of pain is often all that is needed to relieve the patient, but if the pain is very severe or long continued, it is better to consult a physician, for the disease sometimes becomes chronic, and is then known as *pleurisy with adhesions*. This may be a serious condition, requiring skilled treatment, for if at all extensive the lung becomes attached to the chest wall by little bands which interfere with its expansion.

Subacute pleurisy, or *pleurisy with effusion* (or *water on the chest*), is a much more serious disease. Here a large portion of the pleura of one lung becomes inflamed, and a large amount of serum, or water, is poured out into the space between the two pleuræ, separating the lung from the chest wall and compressing it more or less. This disease may persist for months, and may even result fatally.

Subacute Pleurisy: Symptoms and Treatment.

The patient may be taken sick suddenly with a high fever and all the symptoms of a pneumonia, or he may become ill so gradually that he is hardly aware that anything serious is the matter with him for a long time. I once saw a gentleman who told me that he had had malaria and an enlarged spleen for three months. An examination showed at once that he had no enlarged spleen, but that his left chest was full of fluid. This was his "malaria." Whether the disease comes on suddenly or insidiously, the patient has more or less fever, considerable or great prostration, shortness of breath, cough, with little or no expectoration, and usually pain over the affected side. The degree of fever and shortness of breath varies very much. Those in whom the disease comes on suddenly and severely have a high fever, and often such severe breathlessness that they can not lie down in bed. Those in whom it comes on gradually have usually only a moderate amount of fever, and are only conscious of breathlessness when they attempt any exertion, as on walking or working.

The treatment is always rest in bed—for a time, at least—and the patient should invariably consult a physician, since the fluid must be removed in various ways, as by diuretics or by aspiration.

Empyema, or *pus in the chest*, is a still more grave form of pleurisy. In this disease an abscess forms in the pleural cavity (as the space between the pleura on the lungs and the pleura on the chest wall is called), and the lung is compressed by the effusion of pus, instead of serum, as in subacute pleurisy. The symptoms are similar to those of subacute pleurisy, only they are much more severe, and the patient usually looks and feels much sicker. His fever is high and irregular, and he is apt to sweat a great deal and to

Empyema: Symptoms and Treatment.

lose flesh rapidly. If he is not promptly and properly treated he becomes emaciated and dies in the course of a few months.

The treatment is always to remove the pus. This may be effected by aspirating the chest and thus removing the pus, or by making an incision in the chest wall and introducing a rubber tube through which the pus may gradually flow. It is often necessary to remove a portion of one or more ribs.

Pneumothorax and its Cause.

Pneumothorax is a rare condition which results from the entrance of air into the space between the pleura on the lung and the pleura on the chest wall. This pneumothorax is caused either by a wound of the chest wall, which penetrates the costal pleura and thus permits the air to rush in through the opening, or it is caused by the rupture of the lung and the pleura covering it. In this latter case, which is the most frequent cause of pneumothorax, there is usually a tubercular nodule in the lung which softens and breaks down, and through the opening thus made the air is pumped from the lung into the pleural cavity. The effect of the air entering the pleural cavity is to cause the lung to collapse and to become useless.

Symptoms.

The symptoms of pneumothorax caused by a rupture of the lung are at first those of pulmonary consumption, such as cough, night sweats, and spitting of blood. Then, during some severe muscular exertion, or even during a fit of coughing, the rupture suddenly takes place and the patient experiences a severe pain in the chest, accompanied by intense breathlessness and a feeling of weakness or faintness. He may even become completely unconscious, and he may die without recovering consciousness. If he does not die at once, he rallies from the shock of the rupture of the lung, but he is much sicker than he was before. He has great and constant breathlessness, since he now has only one lung to breathe with, and he is usually confined to his bed. He may remain in this condition for two or three weeks and then die, or he may grow stronger and be able to get out of bed and go about a little, but he soon develops a purulent pleurisy in addition, and the disease is then known as *pyopneumothorax*, or *air and pus in the pleural cavity.*

Pyopneumothorax.

That is to say, he has part of the pleural cavity filled with pus and the rest of it filled with air. The patient under these circumstances can often feel the fluid splashing in his chest, and he can sometimes even hear the splash. When a patient has pyopneumothorax he is very much sicker than he was from the consumption which caused the perforation of the lung. He loses flesh rapidly, has a high fever at night, and perspires profusely. Afterward he expectorates a great deal of foul-smelling material, which is the pus from the pleural cavity. As a rule, little can be done for the unfortunate victim, because an operation for the empyema does no good, since the disease of the lungs

is the main cause of the inflammation of the pleura. All we can do is to treat the consumption by cod-liver oil and tonics. In a few fortunate cases the consumptive process is arrested, and then we treat the case as if it were an empyema, and by opening the chest and removing a large portion of one or more ribs we have a very fair chance of effecting a cure.

CHAPTER II.

DISEASES OF THE BRONCHI.

Laryngo-tracheitis.

LARYNGO-TRACHEITIS is a mild inflammation of the larynx and trachea commonly known as a slight "cold." The larynx, or voice box, is the cartilaginous organ situated in the neck and generally known as the "Adam's apple." (See *The Anatomy of the Human Body*, Figs. 53, 54, and 55, and *Physiology: The Vital Processes in Health*, Fig. 22.) This leads to and is continuous with the "windpipe," or trachea, and contains the vocal cords or mechanism by which the voice is produced. The trachea is the large tube that conducts the air into the lungs. (See *Physiology: The Vital Processes in Health*, Fig. 9.) The trachea is made up of rings of cartilage, or gristle, that can easily be felt in the neck below the larynx. The larynx and trachea are lined with mucous membrane, a soft covering similar to the velvety covering of the lips. When the larynx and trachea become inflamed this mucous membrane becomes red and swollen and covered with an increased amount of exudation or mucus.

Causes.

This inflammation of the larynx and trachea is usually the result of exposure to sudden changes of temperature, or to cold and wet. It may be caused, however, by mechanical irritation, as by the inhalation of smoke, or the fumes of ammonia, or other irritating substances.

Symptoms and History.

The disease often begins with a cold in the head and extends down to the larynx. Then the patient has a dry, hard cough and a husky voice, and feels a little feverish and generally indisposed. After a day or two the cough becomes looser, but more severe and paroxysmal, and there is an abundant expectoration of thick, tenacious material, which is "mucus" or "muco-pus." The inflammation usually subsides by the end of ten days, and the patient is as well as before.

The treatment is simply to protect one's self from exposure to cold or damp, and to quiet the cough by a few drops of paregoric, or by the use of mild expectorants, as muriate of ammonia in five-grain doses, taken

every hour. Inhalations of steam are often of service. Sometimes the cold can be aborted by a Dover's powder, or by five or ten grains of quinine, or hot whiskey and water, or a hot lemonade taken at bedtime.

Treatment.

Bronchitis is an inflammation of the mucous membrane of the bronchi. The bronchi are the vast number of air tubes which are continuous with the trachea and which spread through the lungs, becoming smaller and more numerous as they subdivide, just as we see the branches on a tree becoming smaller and more numerous. (See *Physiology: The Vital Processes in Health*, Fig. 9.)

Bronchitis.

A bronchitis is a more severe "cold" than the form just described. Like this, it is generally caused by exposure to cold and wet, but it may be caused by irritating vapours, or by germs, or in the regular winter epidemic which is known as "*la grippe.*" It is also secondary to certain severe inflammations of the lungs, such as pneumonia.

Causes.

When an adult has an acute bronchitis he feels feverish and listless, his appetite is poor, and he has a cough which is sometimes slight and sometimes severe, and which is attended with a more or less abundant expectoration of whitish material, "mucus," or of thick yellow material, "muco-pus." There is soreness or pain under the breast bone, and there may be shortness of breath, or even asthmatic attacks. The disease usually lasts from two to three weeks, and then the patient recovers perfectly.

Symptoms and History.

The mild cases require no further treatment than that recommended for laryngo-tracheitis. The more severe cases require confinement to the house, or even rest in bed. Ipecac is almost a specific for acute bronchitis, and it may be given in small doses, as ten drops of the syrup of ipecac, or one thirtieth of a grain of powdered ipecac, every hour or two. If the cough is severe it may be quieted by ten drops of paregoric every two or three hours.

Treatment.

If there be a high fever it is advisable to consult a physician.

Chronic bronchitis, or *winter cough*, is usually a part of some disease of the lungs, as emphysema, or consumption; or is due to heart disease. It may occur by itself. It is worse in winter and better in summer. There is but little fever, but the patient is apt to feel weak and sick with it and to lose flesh. The treatment is mainly to be directed to the disease of the lungs or heart, which is the primary cause. Muriate of ammonia, paregoric, and cod-liver oil will aid in checking the cough, and change of climate will often prove of benefit.

Chronic Bronchitis: Symptoms and Treatment.

CHAPTER III.

DISEASES OF THE LUNGS.

Anatomy of the Lungs.

The bronchial tubes terminate in little bags or pockets which have very thin walls, and in these walls there are a great many little blood-vessels. The oxygen from the inspired air passes through these thin walls into the blood-vessels, and is then distributed by the blood throughout the body. The main object in respiration, then, is to draw air into the lungs in order that the oxygen may pass into the blood. The little bags are known as "air vesicles." Each one is smaller than the head of a pin, and there are many millions of them. These air vesicles are divided into groups which are attached to a terminal bronchus (just as in a bunch grapes are attached to the central stem) by little "air passages," and the whole group makes up what is known as a "lobule," which may be said to resemble the whole bunch of grapes. (See *Physiology: The Vital Processes in Health*, Fig. 8.) The lobules are closely united together to form "lobes," each "lobe" making up about one half of the entire lung; so that the lung as a whole consists of bronchi, air vesicles, blood-vessels, and pleura.

Emphysema of the Lungs.

Emphysema of the lungs is a very common disease. It is often called "asthma," although asthma is only one of the symptoms of the disease. Emphysema may be defined as a chronic disease of the air vesicles and of the bronchi. The air vesicles are dilated, so that they become very much larger than normal. There are inflammatory changes in their walls, and there is interference with the circulation of the blood through the capillary vessels surrounding them. The changes in the bronchi are those of a chronic bronchitis.

The result of these changes is that both lungs become larger than normal, and they contain too much permanent air, while too little fresh air can get into the lungs. Emphysema is usually a disease of middle or advanced age, but it may occur even in children. It is produced in many ways. Repeated attacks of bronchitis may cause it. Tuberculosis may cause it, or it may come on by itself. It is often hereditary.

Symptoms and History.

The chief symptoms are due to the bronchitis, which causes more or less cough and expectoration. This cough is worse in winter and better in summer, and persists year after year. It is therefore sometimes called "winter cough." The patient is also apt to feel weak and to lose flesh slowly, though this is not always the case. Shortness of breath on any exertion is very common, as are also attacks of spasmodic asthma. These attacks of asthma may

come on at any time, but they are more frequent at night. They are so severe that the patient is often obliged to get out of bed and sit upright, with his head and arms upon the back of a chair, in order to get his breath. They will be described more in detail in the article upon *Asthma.* So the patient goes on for a great many years, having more or less cough and expectoration and more or less shortness of breath, and feeling more or less "poorly," until he finally dies of some entirely different disease. The common belief that the subjects of "asthma" will be long-lived is therefore not altogether erroneous.

In some cases of emphysema, however, the patients have few of the ordinary symptoms of this disease, but they act as if they had consumption. They lose flesh and strength rapidly, and die in the course of a few years.

Treatment.

In considering the treatment it must be remembered that emphysema can rarely be cured. The bronchitis can be controlled and the asthmatic attacks much relieved, but the air vesicles never return to their natural condition. Change of climate often promises the greatest relief. A high, dry climate is the best, as Colorado, or even southern California; but the individual can often find by experience where he is most comfortable. The drugs used are those which help the bronchitis and relieve the asthma. Iodide of potassium, in five- to ten-grain doses three times a day, or muriate of ammonia, in ten-grain doses, frequently repeated, or small and frequent doses of ipecac, will help the bronchitis. The asthma may be relieved by teaspoonful doses of Hoffman's anodyne, frequently repeated, or by the inhalation of the fumes of burning stramonium, or saltpetre, or tobacco. In severe cases inhalation of ether or chloroform may be tried, or morphine injected hypodermically, but none of these last three remedies should be used without the advice of a physician. General tonics, as iron and cod-liver oil, are of service if the patient is weak and losing flesh.

PULMONARY CONSUMPTION.

Pulmonary consumption (or *pulmonary phthisis*, or *pulmonary tuberculosis*) is a form of lung disease which is very common and very fatal, as is well known. It is a disease which is usually *chronic*—that is, which progresses slowly and permits the patients to live several years, but which is sometimes *acute*, or runs its course in a few weeks.

The Tubercle Bacillus.

We now know that consumption is an *infectious* disease, by which we mean a disease which is produced by infection, or the introduction into the body of a material which causes the disease. The infective material in this case is a minute living organism, commonly called a "germ," which produces in the lungs the characteristic morbid changes of tuberculosis. This germ, which can only be seen by the aid of a very strong microscope, is shaped

like a little stick of wood, or "rod-shaped," and since it is rod-shaped, the scientific name "bacillus" is given to it, for all rod-shaped germs are called "bacilli." The particular bacillus which produces consumption never causes any other disease, and it is therefore known as the *tubercle bacillus.*

Causes, Immediate and Predisposing.

Consumption, then, is caused by the entrance into the lungs of tubercle bacilli, which, by their rapid increase, cause a great many changes in these organs, the most common of which is the production of a great number of little grayish bodies of about the size of a pinhead, called *tubercles.* There may be pneumonic consolidation, pleurisy and bronchitis also, and cavities may form in the lungs. The tubercle bacilli are carried into the lungs, along with particles of dust, by the inspired air, but they are sometimes introduced into the stomach by milk from tuberculous cows, or by insufficiently cooked meat from tuberculous animals, and, being taken up by the blood, are carried to the lungs.

The bacilli which are inhaled are derived from the dried expectoration of persons suffering from tuberculosis. Such persons expectorate freely, and this expectoration is often swarming with the tubercle bacilli. Since this is the case the question arises, Why are not more persons attacked by this disease? and the answer is found in the fact that something more than the mere taking of the bacilli into the lungs is required to produce consumption. In the first place, there must be a predisposition on the part of the individual to acquire the disease—that is, a peculiar tendency in the individual to favour the growth of the bacilli, just as certain soils are favourable for the growth of certain seeds. In the second place, environment affects the growth of the bacilli, and the conditions may be such that the bacilli can not increase. That is to say, an individual may be kept under such fine sanitary conditions that the tubercle bacilli will not increase, even if taken into the lungs of one with the predisposition to consumption. In other words, they can not grow in that soil under those conditions. Finally, the bacilli are much more abundant in some localities than in others, as in damp, low places and those unexposed to sunlight, while at high altitudes and on the ocean the air contains none of these germs. It follows, then, that *for the production of consumption we must have a constitutional predisposition to the disease, proper environment, and the growth of the tubercle bacilli in the lungs.*

Sex makes little difference in regard to the liability to consumption, nor are there any limitations as to age; the babe of a few months or the old man may contract the disease, but it is most common under thirty years of age, as there are more living people under than over this age. It is well known that it is a disease which runs in families. It is more prevalent among the poor than among the rich, but only because their

environment is not so favourable. It is more common in cities than in the country for the same reason.

The cases of acute consumption act like cases of pneumonia, or like typhoid fever, and therefore need not be mentioned here.

Symptoms.

In cases of chronic consumption the patients have usually six definite symptoms. They have cough; they lose flesh and strength; they have a rapid pulse; they have fever; they have night sweats; and they have bleeding from the lungs. Every case does not present all these symptoms, however, for spitting of blood, fever, night sweats, and cough may all be absent, either entirely or for a long time. Bleeding from the lungs is so commonly found associated with consumption that it is always regarded as a grave symptom. In fact, many cases of consumption are first recognized by a sudden hæmorrhage occurring in a patient previously thought to be in perfect health. Bleeding from the lungs may be so slight as to simply tinge the expectoration, or it may be so extensive as to amount to half a pint of blood. A hæmorrhage from the lungs always frightens the patient, but it rarely does harm, and often does good by relieving the congestion of the lung. *Death from hæmorrhage of the lungs is of the utmost rarity.* Fever is usually present during some part of the twenty-four hours. It usually comes on about three or four in the afternoon, when the patient begins to feel restless and "miserable," and he notices that his cheeks are flushed and his lips dry. Then it lasts through the night. Sometimes it does not come on until late in the evening. Sometimes it is only noticed during the forenoon. In the more severe cases the fever is continuous and the temperature is high, the thermometer registering 100° to 101° in the morning and 102° to 104° in the afternoon. The night sweats are less common than the other symptoms, but they are frequently present. They are usually cold sweats, and they weaken the patient so that he wakes up in the morning unrefreshed.

The cough is a very constant symptom. It is at first only slight and without much expectoration. After a time it becomes more severe, and the expectoration becomes abundant, thick and heavy, and yellow in colour. When the disease is well advanced the cough is very distressing, and is often so severe as to cause the patient to vomit. The loss of flesh and strength is very characteristic of the disease. In the course of a few months the patient "looks consumptive." His face is thin, the cheek bones are prominent, the ribs show through the skin, and his hair becomes dry and thin or prematurely gray. The loss of strength is progressive, but it is so gradual that the patient continues at his work for a long time.

The pulse-rate is increased often to one hundred a minute or more and its frequency out of proportion to the fever or weakness. It is one of the most constant symptoms of consumption.

There are a number of secondary symptoms which may be present. The digestion is impaired and the patient is dyspeptic. Frequently there is vomiting independent of the coughing. In some cases this vomiting is the prominent symptom, and, taken together with the loss of flesh and strength and the absence of spitting of blood and night sweats or cough, may lead to the error of regarding the disease as cancer of the stomach.

Sometimes the tubercle bacilli pass into the intestines, and, producing inflammatory changes there, give rise to a chronic diarrhœa. Sometimes there is tubercular inflammation of the larynx and the voice becomes permanently husky. There may also be shortness of breath; but many of these patients, although obviously breathing rapidly, are conscious of but little breathlessness. Some suffer from pain in the chest and others do not.

History.

The duration of the disease is uncertain. Some patients go on with moderate cough and occasional spitting of blood and moderate loss of flesh and strength for many years. Others die within two or three years from the first symptoms of the disease. A moderate number have a limited degree of tubercular inflammation of one or both lungs and yet recover perfectly. Such patients may die years afterward of some other disease, and a post-mortem examination of their lungs will reveal only scars or chalky masses at the points where the tubercular inflammation had formerly been recognised by the physical examination of the lungs.

Treatment.

The treatment of consumption is twofold. The first and most important object is to prevent the spread of the disease to those as yet unaffected. The second is the management of those already attacked.

To prevent the spread of tuberculosis it should be remembered that one tuberculous individual may infect many others. The expectorations of a consumptive contain many bacilli, and if the expectoration be recklessly thrown upon the floor of the room or upon the street it becomes dry, and mixing with other particles of dust, these bacilli may be drawn into the lungs of a healthy person and there set up a tubercular inflammation anew. The consumptive should therefore be careful not to indulge in reckless spitting. The expectoration should be received into bits of Japanese paper or rag, which must be burned while damp, or into strong envelopes waterproofed, or little bottles or pasteboard boxes (see *Nursing the Sick*, Figs. 23 and 24) which the patient may carry round with him and empty and clean frequently; or if he be confined to the house, the expectoration should be received in a cuspidor which is frequently cleaned.

The consumptive should, if possible, always sleep in a room by himself. Certainly he should sleep in a bed by himself. The room should be frequently aired and frequently cleaned, care being taken to dampen

the floor so that the dust shall not be spread about. Dairymen and butchers should be careful that their milk and meat are from healthy animals. The children of consumptive parents should be carefully watched and placed under the best possible hygienic conditions. The same is true of delicate individuals who may come in constant contact with consumptives.

The treatment of the patient who has contracted consumption consists chiefly in building him up in every possible way, so that the system may become strong enough to counteract the poison of the bacilli and to check their growth. This is affected by freeing him from anxiety as much as possible, by favouring an out-of-door life, by sufficient and nutritious food, by proper ventilation of the sleeping room at night—for fresh air, even if cold, never does any harm—and by selecting a sunny room.

If it can be arranged, change of climate is a very important method of treatment. Many improve wonderfully when sent to the Adirondack Mountains or to Colorado. Some do better in a warm climate, as Florida, or Georgia, or southern California, or Algeria. Some do better at sea or on the seashore. *But, wherever they go, they must live out of doors as much as possible.* Cod-liver oil, milk, and cream all help to improve the patient's nutrition, and should be partaken of as freely as possible. The daily cleansing of the skin of the whole body is also important. A bath and a quick, brisk rubbing will help wonderfully, and there is no danger of "taking cold" in the process.

The most important of the drugs which may be employed is creosote, which may be taken into the stomach or inhaled through an inhaling apparatus. Iron, bitter tonics, and alcohol may be required, and various sedatives may be used for the cough.

PNEUMONIA.

Pneumonia (or *pneumonitis*, or *lung fever*, or *inflammation of the lungs*) is a disease which involves the air vesicles, the air passages, and the smaller bronchi, and regularly has associated with it the inflammation of the pulmonary pleura. There are several forms of such pneumonia, which we designate by various names, such as lobar pneumonia, broncho-pneumonia, secondary pneumonia, pneumonia of heart disease, chronic interstitial pneumonia, and several others. The most important of these are lobar pneumonia and broncho-pneumonia.

Lobar pneumonia is so called because it usually involves at least one lobe of a lung. It is an acute infectious disease attended with the growth in the lung of certain "germs" or "bacteria."

These germs are found in the expectoration of patients who are sick with pneumonia, and this expectoration when dried may be carried in the form of dust into the lungs of healthy persons, and there set up a fresh

pneumonia. But the presence of the germs alone does not seem sufficient to cause a pneumonia, for they are frequently found in the mouths, or in the saliva, or in the nasal secretions of healthy persons. There must be in addition an exposure to cold in order to produce the pneumonia. Persons who fall into the water often develop pneumonia after the immersion. It seems as if the sudden chill enables the germs to successfully attack the lung.

When a patient contracts pneumonia the germs multiply very rapidly, and by their growth form poisonous chemical products (called "toxines") which poison the whole system. The portion of the lung inflamed becomes solid by the filling up of the air vesicles by these germs, and by exudation from the blood-vessels in the walls of the air vesicles. When the patient recovers, this exudation disappears and the lung is left perfectly healthy. A lobar pneumonia may involve one lobe of one lung or the whole lung, or parts of both lungs. In the latter case it is called "double pneumonia."

Pneumonia is found in almost every part of the world. It occurs at all times of the year, but in countries in the temperate zone it is most frequent from February to May. It may occur at any age from five years up and in either sex. The feeble and weak are rather more liable to the disease than the strong and robust. It is less common in the country than in the city.

Symptoms.

The symptoms of pneumonia usually come on suddenly. The patient after exposure has a sharp chill, followed by fever and great prostration, and is usually obliged to take to his bed at once. Within a few hours there is developed a short, dry, hard cough, and sharp pleuritic pain on the affected side. This pain is usually felt just below the nipple. There is soon added a thick, tenacious expectoration which is blood-stained, and which usually looks as if it had been used to wash rust off old iron. Hence the name "rusty sputum." This expectoration is characteristic of the disease. Sometimes there is no blood in the sputum. Sometimes there is a great deal of bright-coloured blood in it. This is especially the case in the pneumonias due to consumption. Sometimes the sputum is very dark like prune juice; this betokens a very grave case.

The patient goes on in this way, with a high fever, the thermometer indicating from 102° to 105°, a rapid and full pulse, rapid respiration (about forty to the minute), and a great sense of breathlessness, cough, pain in the side, and perhaps delirium, for about a week; then the fever suddenly leaves him and he rapidly returns to health.

The appearance of a patient suffering from pneumonia is very characteristic. His face is anxious and there is a deep-red flush upon one or both cheeks. His breath is short and his sentences are broken by his

breathlessness. He usually lies upon his back, but he may lie upon the affected side so as to give full play to the healthy lung.

The disease may run its course in anywhere from two to eighteen days. The seventh day is the most common day for the "crisis," as the fall of temperature is called, to occur. If the disease is prolonged beyond the eighteenth day we always fear that the pneumonia is due to consumption, although a pneumonia may last a month.

In the case of pneumonia which is due to *la grippe* the duration is longer. Here the disease may last several weeks, and the temperature, instead of falling suddenly, will rise and fall from time to time until it finally reaches the normal by slow degrees.

In the pneumonia due to *la grippe* also there is less general disturbance, and the patient, as a rule, is not so sick.

Pneumonia is not necessarily a fatal disease. If properly taken care of, the majority of the cases recover perfectly.

Treatment.

The treatment is always rest in bed, fluid food, chiefly milk, and such medicine as is required to sustain the heart, to quiet the pain and restlessness, and to procure sleep. In very bad cases oxygen may be inhaled. Such a serious disease as pneumonia should be treated by a physician at the earliest possible moment.

Broncho-pneumonia.

Broncho-pneumonia (or *lobular pneumonia*, or *capillary bronchitis*, or *suffocative catarrh*) is the form of pneumonia which is always found in infants under five years of age, and occasionally in adults. It may be due to exposure to cold or it may be due to germs, as in influenza. It may be secondary to a general bronchitis, or to measles, or to whooping cough.

Small areas of consolidation are found in one or both lungs, and there is generally an extensive bronchitis.

Symptoms in Children.

The symptoms in children depend somewhat upon the age. Infants under one year may have nothing but fever, prostration and rapid breathing. They usually die. Older children have cough without expectoration, because they swallow the latter, fever, rapid breathing, great prostration, and loss of appetite. Sometimes they have convulsions. Sometimes they have delirium, or alternate from delirium to stupor, with or without convulsions, and then they look very like cases of inflammation of the brain. In cases of broncho-pneumonia and also in acute bronchitis in children there may be so much mucus in the bronchial tubes that its vibration, caused by the movements of the air in the bronchi, produces a thrill that can be felt all over the chest similar to that felt when a cat "purrs." Experienced mothers recognise that a child has an extensive bronchitis in this way. They "feel it in his chest," they say. It must be remembered that this sign is not always present, nor is it an index of the severity of

the broncho-pneumonia, and that it may be due to bronchitis alone. The disease lasts from a few days to four weeks. The fever does not break suddenly, as in lobar pneumonia, but subsides by degrees.

The majority of cases in children over one year old recover.

Treatment.

The treatment is to keep the child in bed if possible; if not, to hold it quietly in the arms. The food should be milk or beef tea. Ipecac, muriate of ammonia, or belladonna may be given for the bronchitis. A few drops of paregoric given occasionally will quiet the cough. Poultices applied to the chest are valuable. If the heart becomes weak, five-drop doses of whiskey frequently repeated are advisable.

When an adult has broncho-pneumonia, the disease sometimes resembles a severe bronchitis, sometimes a lobar pneumonia, and sometimes consumption. In the latter case the symptoms develop slowly and the disease lasts a number of weeks. The fever, the cough, the night sweats, the loss of flesh, and the signs in the lungs all resemble consumption, and the diagnosis can only be determined by examining the sputum with the microscope and noting the presence or absence of the tubercle bacillus, which is found in the sputum in consumption but not in broncho-pneumonia.

The various other forms of pneumonia are usually secondary to other diseases, and their symptoms are those of the exciting disease.

CHAPTER IV.

INFLUENZA OR LA GRIPPE, OR THE GRIP.

Cause and Distribution.

Influenza is an epidemic disease due to a specific germ. Epidemics of influenza have occurred from time to time throughout the whole world for several centuries. The last epidemic reached the United States in October, 1889, and it has prevailed every winter since, though in a more mild form than during the first winter.

The germs attack the mucous membranes more commonly than other parts of the body, although hardly any organ has escaped.

Symptoms and History.

The symptoms are usually those of a severe cold, with an extraordinary degree of prostration and great mental depression. Neuralgic pains in various parts of the body are also very common. There is usually a high fever, a temperature of 103° or 104° being very frequently observed. The disease lasts for about a week, and then the cough, the pains, and the fever subside, but the patient feels weak and languid for a long time.

In the more severe cases of influenza there may be a very intense bronchitis, or a pneumonia, or pleurisy with effusion, or empyema, or pericarditis.

In even mild cases there may be inflammations of the eyes or a suppurative inflammation of the middle ear.

Treatment.

There is no specific by which we may treat the disease. All that is necessary to do in an ordinary attack of influenza is to treat it as a severe cold. Stay in the house, if possible, or even in bed. The diet should be light. If there is much pain or high fever, phenacetine in five-grain doses, four or five times a day, will give relief. For the depression and muscular weakness alcohol or bitter tonics may be used. *If there be a severe bronchitis, or a pneumonia, the patient should be treated by a physician.*

CHAPTER V.

ASTHMA.

By asthma we mean paroxysmal attacks of breathlessness caused by spasmodic contractions of the bronchial tubes. Asthma may be a symptom of various diseases, as bronchitis, emphysema of the lungs, heart disease, disease of the kidneys, or gout and rheumatism. It may be a purely nervous phenomenon; or due to climatic conditions; to the odour of certain drugs, as rhubarb and ipecac; to the pollen of vegetations, as in "rose cold" and "hay fever"; to the emanations from animals; and to various abnormal conditions of the nose. Bronchitis is the most frequent cause of asthma. Asthma is frequently hereditary.

Symptoms.

Asthmatic attacks usually come on suddenly at night. The patient has a feeling of suffocation, his breathing becomes shallow and laboured, with loud, crisp, or wheezing sounds, which hospital patients aptly describe as "whistling in their pipes." The feeling of suffocation is so intense that the patient has to sit up in bed, or get up and rest the elbows on a table, or sit by the open window. He becomes pale, and the skin is often covered with perspiration. During the most severe attacks it seems as if the patient might die at any minute, but in simple asthma he never does. After a few hours the attack subsides. Some patients have asthmatic attacks in the daytime, and others have attacks which last both day and night for a long time.

The treatment is directed toward the exciting cause, if such there be. The bronchitis must be treated, or the abnormal condition of the nose corrected. In many cases change of climate or change of location

is the only means of relief. Some patients are comfortable in New York city, and can hardly breathe ten miles outside of the city. Each individual has to learn by experience where he is most comfortable. To cut short an attack of asthma we may use various medicinal agents. The patient may inhale the fumes of stramonium, or of burning saltpetre, or of tobacco. He may burn any of the asthma pastilles or powders which are sold by the druggists. The inhalation of ether or chloroform may be used, or morphine may be administered hypodermically.

Treatment.

CHAPTER VI.

HÆMOPTYSIS, OR SPITTING OF BLOOD.

Spitting of blood is regarded by the non-medical public as an almost infallible sign of consumption. This is not really the case. Bleeding from the lungs, indeed, constitutes the chief source of hæmoptysis, and consumption is the most common disease which leads to the bleeding; but the blood may come from other sources than the lungs, and it may come from lungs which are free from consumption. Dr. Delafield describes eleven forms of hæmoptysis which occur without consumption:

Causes.

1. A person has one attack of hæmoptysis, only lasting a short time, during which he raises a considerable quantity of blood. The bleeding may follow severe muscular exertion, great mental excitement, or occur without discoverable cause.

2. In women hæmoptysis may take the place of menstruation. This is, however, so rare that we always fear tuberculosis will develop.

3. Chronic nasal catarrh may be attended with occasional small losses of blood. The blood trickles down the back of the nose and into the mouth.

4. Poorly nourished and anæmic women may cough up a little blood from time to time.

5. It is said that pregnant and nursing women sometimes have hæmoptysis.

6. Patients with heart disease may cough up blood from time to time in considerable quantities.

7. Aneurisms of the branches of the pulmonary artery within the lungs, when they rupture, cause fatal hæmorrhage, a large part of the blood being coughed up. Aneurisms of the arch of the aorta (or the great blood-vessel leading from the heart), which ulcerate the trachea or main bronchi, may rupture into these tubes by small or large openings. With the small

openings the patients cough up a little blood from time to time. With large openings they bleed to death in a few minutes.

8. Very rarely *elderly gouty persons* have hæmoptysis.

9. Very rarely persons apparently well have blood in their expectoration for a long time without assignable cause.

10. Injuries inflicted upon the wall of the chest, as from a fall from a horse, may be followed by the expectoration of blood for hours or days.

11. Patients who suffer from emphysema and chronic bronchitis not infrequently cough up small quantities of blood from time to time. Much less often such patients have a large bleeding from the bronchial tubes.

Treatment.

The treatment of hæmoptysis is rest in bed, the administration of morphine, or of gallic acid, or of dilute sulphuric acid, or of ergot. Salt taken in large quantities—a teaspoonful or more upon the tongue—will sometimes check the bleeding. Ice may be applied to the front of the chest and kept there until the bleeding stops.

CHAPTER VII.

DISEASES OF THE HEART.

Anatomy of the Heart.

The heart is a hollow muscular organ the function of which is to force blood throughout the body. (See *The Anatomy of the Human Body*, Figs. 25 and 27.) The heart may therefore be regarded as simply a pump. There are really two pumps placed closely together, and known as the right heart and the left heart. The function of the right heart is to pump the blood into and through the lungs; the function of the left heart is to pump the blood which has passed through the lungs, and is now charged with oxygen, throughout the body. Since the left heart has to drive the blood much farther, it is stronger than the right heart—that is, it is more muscular. It is also more liable to disease. The heart, as a whole, consists of four cavities—a right auricle and ventricle and a left auricle and ventricle.

The course of the blood is from the veins into the right auricle (which is really a funnel for the collection of the blood) and through an opening, which is guarded by a valve, into the right ventricle (or pump), then through a large tube, the "pulmonary artery," the opening of which is also guarded by a valve, to the lungs. (See *Physiology: The Vital Processes in Health*, Fig. 5.) From the lungs the blood passes to the left auricle and through the opening, guarded by a valve, into the left ventricle, and

then through the large distributing tube, or aorta, likewise guarded by a valve, to the tissues of the body. From these tissues the blood is returned by the veins to the right auricle. This is called the circulation of the blood. The four valves, which are little, thin, membranous curtains, all open in such a way that the blood can go forward but can not go backward. The heart and its blood-vessels might be compared to a Davidson syringe.

The interior of the heart is lined with a thin, smooth membrane, which permits the blood to pass through the heart without friction. This is scientifically known as the *endocardium*. The heart is placed within a bag which is smooth and shiny on its inner side, so that the heart may expand and contract easily, and is tough and fibrous on the outer side, so that the heart may be protected. This bag is known as the *pericardium*. There are two layers of the pericardium, one covering the heart, the other lying against the lungs.

In considering diseases of the heart we may speak conveniently of diseases of the endocardium; of the heart muscle; of the pericardium; and of some nervous derangements of the heart.

Valvular Disease of the Heart.

Disease of the endocardium is the most frequent form of heart disease. It is commonly known as *valvular disease of the heart* because the valves are attacked by the inflammation and, becoming distorted, fail to perform their functions. The result is often a very serious disturbance in the action of the heart, causing derangements in the circulation of the blood, with far-reaching effects as regards the functions of various organs, as the brain, the lungs, the stomach, the kidneys, etc.

The reason for all this disturbance is found in the failure of the heart to properly perform its office as a pump. If in a water pump a valve be deranged the pump will not work properly. If a valve be deranged in the heart this pump will not work properly, and the result is that the blood does not circulate regularly through the body, but instead of that it moves sluggishly, or even stagnates in certain parts. This we call *congestion*; and since the tendency is for the blood to accumulate in the veins, we call it *venous congestion*. This venous congestion of the brain causes headache; of the lungs, causes breathlessness, cough, or spitting of blood; of the stomach, causes dyspepsia; of the kidneys, causes scanty urine or Bright's disease. The congestion of the veins of the legs causes the water of the blood to exude through the walls of the veins into the loose tissue beneath the skin and produces dropsy of the lower extremities. The congestion of the veins of the upper part of the body makes the finger tips and the cheeks and lips dusky in colour, or "blue."

The heart muscle is also affected by the derangement of the circulation. In order to correct the faulty action of the valve, it works more forcibly or more rapidly, and through the stimulating influence of in-

creased exertion the muscle of the heart is enlarged. This is called *hypertrophy of the heart.* If by the increase of the muscular force of the heart the bad effects of a slightly damaged valve are corrected, it is called *compensatory hypertrophy.* If, however, the derangement of the valve is more extensive, the nutrition of the heart is soon affected, and the heart muscle, instead of remaining thicker and stronger, as in hypertrophy, becomes thinner and weaker and less able to pump the blood onward. This we call *dilatation of the heart,* because the cavities of the heart are enlarged. This dilatation causes *palpitation of the heart,* a feeble and irregular pulse, very great breathlessness on any exertion, attacks of faintness, general loss of flesh and strength, and, finally, death.

Diseases of the endocardium, or endocarditis, may be divided into three classes—viz., acute inflammation of the endocardium, chronic inflammation of the endocardium, and infectious or malignant endocarditis.

Acute Endocarditis.

Acute endocarditis is caused in the great majority of cases by rheumatism, less frequently by the infectious diseases, particularly scarlet fever, and it is occasionally found as a complication of disease of the kidney. Sometimes it appears to develop without any antecedent cause, but it is a question in these cases whether it is not a primary rheumatic inflammation of the endocardium. In some cases the primary rheumatic inflammation of the joints is so slight as to be overlooked. This is particularly the case in children, where the slight pains they complain of in their joints are ascribed to "growing pains."

Symptoms.

Such an acute endocarditis usually causes a moderate swelling of one or more of the valves of the heart, and shows itself by a *murmur,* or soft blowing sound, heard on listening to the heart; or by some little increase in the rapidity and force of the heart's action. In the majority of cases this inflammation subsides as the primary disease which caused it subsides, and the heart is left perfectly healthy. Occasionally the inflammation is more severe and impairs the function of one or more valves a little, and though the endocarditis subsides, it leaves a slight permanent damage of the valve, or valves. This, however, is so slight as to do little or no harm to the patient, who may live a long life without ever being aware of this condition. In other cases, however, the inflammation does not subside with the primary disease, but becomes chronic and leads to permanent and serious injury of the valves.

Treatment.

The treatment of acute endocarditis is directed to the disease which causes it. Since rheumatism is the principal cause, active treatment is directed to the rheumatism to forestall the endocarditis, if possible. The various preparations of salicylic acid, salophen, and alkalies, such as bicarbonate of sodium, are the drugs employed.

Chronic endocarditis may follow an acute endocarditis, or the inflammation may be chronic from the beginning. The causes of chronic endocarditis are the same as those of acute endocarditis. The disease goes on for a long time, and the effect is to damage the valves of the heart very considerably. The aortic and mitral valves are the ones commonly affected, either one or both. The aortic valve is that which guards the opening of the aorta; the mitral valve is that which guards the opening from the left auricle into the left ventricle. The changes in the valves may be such that the blood passes through the aortic or mitral orifice with difficulty, or that the blood, having passed through the mitral or aortic orifice, leaks back again.

Chronic Endocarditis.

The symptoms of chronic endocarditis depend upon the valve, or valves, attacked, and upon the degree of damage to the valves. In some cases the damage to the valves is only moderate, and the inflammation is slow in its progress or ceases altogether after a time. Here the heart hypertrophies enough to compensate by its increased force for the imperfect action of the valve, and the normal circulation is consequently maintained. There are, therefore, no symptoms of the disease. In other cases the disease is progressive and the damage to the valves extensive, and we then find the serious symptoms of dilatation of the heart and disturbance of the circulation developing more or less rapidly.

Symptoms.

The duration of valvular disease of the heart varies within very wide limits. It was formerly believed that valvular disease of the heart and speedy death were almost synonymous terms, but we now know that this is not the case. Neither speedy death nor sudden death is probable. Many persons with very extensive valvular disease of the heart live in comparative comfort for a great many years, and die from some other disease. Neither is sudden death to be expected in valvular diseases of the heart. It *may* occur, but it is the exception.

Prognosis.

The treatment of chronic endocarditis depends upon the character of the valvular derangement and the degree of compensating hypertrophy of the heart. In many cases no direct treatment of the heart is necessary, sufficient exercise and a proper regard for hygienic laws being all that is required. Because a person is known to have heart disease is no reason why he should be doomed to the life of an invalid. He may indulge in all the ordinary out-of-door sports, and he may attend to his business with the exercise of ordinary prudence. Before the compensatory hypertrophy of the heart has been established, or after it has begun to fail, we have to guard the patient more carefully. Exercise is to be taken, but with discretion, and business

Treatment.

cares and anxiety are to be avoided as much as possible. The diet should be carefully regulated. Then there are many drugs which will strengthen the heart's action and favour hypertrophy. The principal of these is *digitalis.* As accessories, strophanthus, convallaria, strychnine, and the like may be used. Iodide of potassium, nitroglycerin, and morphine dilate the blood-vessels and thus make the work of the heart more easy, so they also help the weak heart.

In the most severe cases of dilated heart rest in bed, together with some of the above drugs, is absolutely imperative. Such rest in bed often enables the flagging heart to recover its tone after a while, and the patient may then go back to work and remain in comfortable health for a long time.

Infectious Endocarditis.

Infectious (or *malignant*, or *ulcerative*) *endocarditis* is a disease which is usually acute and usually fatal. Its duration is about three weeks. The disease is due to germs which, attacking the endocardium, cause ulcerations and "vegetations," or little soft excrescences upon the valves, and by their growth produce a poisonous substance called "toxine," which infects the whole system. The vegetations are very soft, and pieces of them containing the germs are frequently broken off by the blood current and are carried in it to distant parts of the body, where they lodge in small blood-vessels and form abscesses.

Infectious endocarditis may occur as a primary disease; more commonly it is secondary to some acute infectious disease, such as pneumonia or childbed fever.

Symptoms and Treatment.

The symptoms are mainly a high fever, which may abate from time to time, irregular chills, and sweating. For this reason it is sometimes mistaken for malarial fever. Sometimes it resembles typhoid fever, and sometimes hasty consumption. Sometimes the germs are carried by the blood into various parts of the body and thus cause abscesses, or by blocking up little blood-vessels in the skin they cause little hæmorrhages, which give portions of the skin the appearance of being covered with little "black-and-blue spots."

It is doubtful if any treatment is of avail, but large doses of quinine may be tried, and whiskey or brandy administered.

The most important diseases of the heart muscle are acute dilatation of the heart, fatty heart, and angina pectoris. Hypertrophy and dilatation of the heart due to endocarditis have already been described. Simple hypertrophy of the heart may also occur with Bright's disease, and chronic dilatation of the heart may result from Bright's disease, emphysema of the lungs, and other less common conditions.

Acute dilatation of the heart is a sudden weakening of the heart

which results in a dilatation of its cavities and a thinning of its muscular wall. It occurs in individuals who have laborious occupations, and mostly in those who indulge in excessive beer-drinking. The symptoms are those of failure of the pump action of the heart. There is sudden breathlessness, great weakness, blueness of the lips and finger tips, palpitation of the heart and dropsy.

Acute Dilatation of the Heart.

If not properly treated, the disease may end in death in a few weeks or months. If properly treated, the prospect of recovery is good. The patient must usually be put to bed, and digitalis, strychnine, alcohol, or other cardiac stimulants administered. The diet must be light or altogether fluid so as to relieve the digestive functions from all unnecessary effort.

Fatty Heart.

Fatty heart is a disease of the heart muscle which consists in a degeneration of the muscular fibres so that much of the muscular tissue is replaced by fat. There are various causes which lead to it. There may be an interference with the nutrition of the heart through disease of the arteries which supply the heart muscle with blood. Alcoholic excess may produce it; or a sedentary life may be the cause. It may be caused by typhoid fever; diabetes; or anæmia. A less serious form of fatty heart occurs in corpulent persons. It consists in a deposit of a thick layer of fat about the heart.

The symptoms are those of weak heart action, as breathlessness, palpitation, or fainting. There is always great danger of sudden death from rupture of the heart.

The treatment is to improve the patient's general health by proper food and proper hygienic conditions.

Angina Pectoris.

Angina pectoris is a very serious and often fatal disease which is caused most commonly by disease of the arteries which supply the heart muscle with blood. There may or there may not be valvular disease of the heart also.

The symptoms are a sudden agonizing pain in the region of the heart with a feeling of great anxiety and oppression, more or less breathlessness, and pallor of the face. Very often the pain is also felt running down the left arm or down both arms. The patient may die in the first attack within a few minutes, or he may recover and have several such attacks in the course of several years. Angina pectoris is exceedingly rare under forty years of age.

Treatment.

The direct exciting cause of an anginal attack is a sudden contraction of the diseased arteries so that the blood supply is shut off from the heart. The treatment, therefore, is to dilate these arteries as soon as possible. This is best effected by inhaling the fumes of nitrite of amyl, which has a rapid and powerful action upon the blood-vessels. A person who has had one attack of angina pectoris should always carry about with him some "perles" or little glass capsules con-

taining five drops of nitrite of amyl, and he should crush one of these in his handkerchief and inhale the fumes the moment the pain begins to be felt. In this way an attack may be aborted. Sometimes the hypodermic injection of morphine is more effectual. Sometimes the inhalation of ether or chloroform gives relief. To prevent the return of attacks the strictest care should be exercised in regard to the habits of life. Tobacco, and perhaps alcohol, should be absolutely prohibited and all undue excitement or muscular exertion avoided. Iodide of potassium or nitroglycerin may be given continuously in order to keep the blood-vessels dilated. Angina pectoris is so serious a disease that it should be treated by a physician at the earliest possible moment.

Neuralgia of the Heart.

By *pseudo-angina*, or *neuralgia of the heart*, we mean certain symptoms which resemble angina pectoris but which are not so severe and which are not attended by the same danger of sudden death. There is usually paroxysmal pain over the region of the heart, but this pain is not as intense as in angina pectoris and it does not run down the left arm. There is also more or less palpitation of the heart and more or less breathlessness. It may occur at any age. The causes of pseudo-angina are quite numerous. Pseudo-angina may be one of the symptoms of disease of the aortic valves. It may be due to the excessive use of tobacco or tea and coffee. It sometimes occurs in hysterical individuals.

Unless it be caused by disease of the aortic valves it is not a dangerous condition, but if valvular disease is present death may occur in one of the attacks.

Treatment.

The treatment is primarily to correct the conditions which give rise to the attacks. The use of tobacco and tea and coffee must be restricted, and proper food and exercise must be taken. In hysterical patients appropriate measures must be employed. They must be assured that there is no real heart disease, and valerian or camphor and other sedatives may be administered.

The attacks of pseudo-angina do not usually require any direct treatment, but if the pain is severe morphine may be given. Cases of severe pain should always be treated by a physician.

Palpitation of the Heart.

Palpitation of the heart is the too forcible action of the heart, or intermittent action of the heart, or irregularity in the force and frequency of the beats. Such conditions may be associated with severe organic disease of the heart. In many cases there is no disease of the heart whatever, but only a derangement in the nervous mechanism of the heart. Palpitation may be caused by nervousness, or excitement, or by indigestion, or by the excessive use of tobacco, or alcohol, or tea.

The treatment of purely nervous palpitation is to remove the cause by

appropriate measures. If there is organic disease of the heart the various cardiac drugs may be employed.

Tachycardia, or rapid heart, is a peculiar nervous disease of the heart in which the rapidity of the heart's action is very greatly increased. Instead of beating seventy times to the minute, the heart may beat two hundred times to the minute. With this there may be breathlessness and faintness and blueness of the skin. This tachycardia frequently occurs in paroxysms, between which the patient is perfectly well.

Tachycardia.

Tachycardia may be caused by the same conditions which produce palpitation; or by pressure upon the sympathetic nerve; or disease of the pneumogastric nerve; or by either mental or muscular overwork.

The treatment is by digitalis or other drugs which slow the heart's action. Electricity may be of service.

Exophthalmic goître, or Graves's disease, is a nervous affection of the heart in which there is prominence of the eyeballs, enlargement of the thyroid gland (or goître), and rapid and forcible heart action.

Exophthalmic Goître.

The treatment is the same as that of tachycardia.

Pericarditis, or water on the heart, is an inflammation of the pericardium, or the membrane which surrounds the heart. As a result of this inflammation, the adjacent surfaces of the pericardium are roughened by a deposit of soft material called fibrin; or, if the disease does not stop here, there is also an exudation of serum or of pus into the space between the two layers of the pericardium. This serum or pus compresses the heart.

Pericarditis.

The causes of pericarditis are the same as of endocarditis—viz., rheumatism, scarlet fever or other infectious fevers, pneumonia, consumption, double pleurisy, and Bright's disease.

The symptoms depend upon the degree of the inflammation. If there is exudation of fibrin only, there is rapid heart action, pain over the heart, fever, and some breathlessness. When the physician listens to the heart he may hear a characteristic "murmur." If there is exudation of serum or pus into the cavity of the pericardium, there will be the same symptoms and, in addition, great breathlessness, blue colour of the skin, feeble, rapid, and irregular pulse, and attacks of faintness.

Symptoms.

The treatment is, in the first place, to treat the disease which is the primary cause. Blisters may also be applied over the heart, or ice may be kept over the heart, or digitalis or strychnine may be given. Of course the patient must be kept in bed, and he should be attended by a physician, as there is often great danger of sudden death.

Treatment.

Aneurism of the arch of the aorta is a disease of the aorta which results in weakening the wall of the aorta, and at some point a pouch or bag is formed by a bulging of its wall. This is very liable to rupture, and death from hæmorrhage follows.

Aneurism of the Arch of the Aorta.

The symptoms are pain in the chest, often the presence of a tumour in the upper portion of the chest which can be seen to pulsate, cough, breathlessness, sometimes a husky voice, sometimes difficulty in swallowing.

The disease may last for a number of years, but there is always danger of rupture of the aneurism and sudden death.

The treatment consists in a quiet life, the administration of iodide of potassium for a long time, and of morphine if the pain is severe. In the most serious cases the patient should be kept in bed.

CHAPTER VIII.

DISEASES AND DISORDERS OF THE DIGESTIVE SYSTEM.

Disorders of the digestion are very frequent in both adults and children, especially the latter. In the large majority of cases such disorders are purely *functional*, or produced by a temporary derangement of one or more of the organs of digestion. In the lesser number of cases there is the more serious condition of change in the tissues of the organs involved, which usually results in prolonged and often in fatal disease.

DISEASES OF THE STOMACH.

The stomach is the large bag in which the food is mixed with the gastric juice and thus liquefied and rendered fit for absorption by the blood. It is situated just beneath the lower ribs on the left side and the lower part of the breast bone.

Derangement of the stomach functions causes symptoms which are known as "dyspepsia." These are a bad taste in the mouth, a coated tongue, eructations of gas, the occasional rising into the mouth of an intensely acid liquid, heartburn, nausea, vomiting, pain upon eating or after eating, a sense of weight or oppression just beneath and below the breast bone, loss of appetite, constipation or an irregular action of the bowels, flatulence, palpitation of the heart, hypochondriasis, and loss of flesh and strength. All of these symptoms are not necessarily present in any one case.

Dyspepsia.

Such a group of symptoms may be produced by a variety of causes, for it only means that the stomach is not doing its work properly. Thus overwork, either muscular or mental, will derange the action of the stomach and cause dyspepsia; anxiety or fright, by interfering with the nervous mechanism of the stomach, will do the same thing. Imperfectly masticated food will cause it. In a like manner improper food or too much food can not be digested and develops these same symptoms. Then in many cases dyspepsia is caused by disease of other parts of the body than the stomach. For example, vomiting in women is a common sign of pregnancy. In a like manner disease of the uterus frequently causes vomiting. Diseases of the kidneys in either sex is frequently attended by dyspepsia. Finally, these same symptoms may be caused by actual disease of the stomach itself, such as cancer of the stomach, chronic gastritis, and the like.

Causes.

It follows, then, that the treatment of "dyspepsia" should be directed straight to the primary and exciting cause and not confined to the stomach symptoms. The use of pepsin and acids and kindred aids to digestion is in most cases to be avoided, or these drugs are only to be taken with the idea of giving temporary relief, while permanent cure will be found by correcting any errors in diet, or by relief from overwork or anxiety, or by treating the disease which causes the dyspepsia.

Treatment.

In those cases of temporary dyspepsia caused by overeating or by eating something which has been imperfectly digested—has "disagreed with one," as many people express it—often all that is required is to take a gentle cathartic, as any of the laxative waters, and to refrain from all food for twenty-four hours, or else to restrict the diet to milk or meat broths for the same period.

Gastritis, or inflammation of the stomach, or gastric catarrh, is an inflammation of the mucous membrane, which results in a diminution in quantity and change in character of the gastric juice and in a deposit of mucus upon the surface of the mucous membrane. All the coats of the stomach may be simultaneously inflamed, but this is rare. Gastritis may be *acute* or *chronic*.

Gastritis.

Acute gastritis is a very common affection. It only lasts for a day or two and is rarely dangerous. It is most frequently caused by errors in diet. The food acts upon the stomach as a direct irritant. The excessive use of alcohol is a frequent cause. Milk which is partially decomposed often produces acute gastritis in children during the heated term. It may be caused by exposure to cold. Many of the symptoms of dyspepsia given above may be present, but *vomiting* is the most constant one. In some cases, particularly in children, *fever* is the most prominent symptom, and the temperature may be

Acute Gastritis.

as high as 104° Fahr. This often leads to the error of regarding the case as one of scarlet fever or other specific fever.

The usual treatment is to refrain from solid food, as mentioned above. If the attack be severe and vomiting has not occurred spontaneously, it may be induced by drinking hot water with salt or mustard, or by an emetic of ipecac.

Chronic Gastritis.

Chronic gastritis, or chronic gastric catarrh, or chronic dyspepsia, is a serious and prolonged inflammation of the stomach, but one which can usually be cured. It is most commonly caused by prolonged errors in diet or overindulgence in alcohol, but it may be secondary to various conditions, as disease of the heart, kidneys, or liver. Exposure to cold and wet, and hardship, will also produce it.

The symptoms are those of dyspepsia extending over a period of months or years. The most common are pain and vomiting, but both may be absent. Blood may be vomited from time to time. The patient gradually loses flesh and strength and looks seriously sick.

Treatment.

The treatment consists in a careful attention to the laws of hygiene—that is, regular and sufficient meals; relief from overwork and worry; proper exercise in the open air; and moderation in the use of alcohol and tobacco, or complete abstinence from the same. The diet must be simple, nutritious, and sufficient. There can be no definite rule as to what to eat and what to avoid, for different individuals will find different articles of food agreeing or disagreeing with them. Fried fat, hot bread, cakes, pies, and candies are to be avoided, as well as rich gravies and fancy dishes. Many patients fall into the error of eating too little at all times, or of restricting the articles of diet too closely. In severe cases of chronic gastritis it may be necessary to confine the diet entirely to milk for several weeks or months. From four to eight pints of milk may be taken daily, and the patients, instead of growing weaker, as they usually fear they will, grow stronger and gain in weight. By the use of a milk diet a perfect cure can very frequently be effected. In the most severe forms of the disease *the most effective treatment is the regular washing out of the stomach each day with warm water.* This is done by introducing a large soft-rubber tube into the mouth and pushing it down the gullet into the stomach. Then water is poured into the stomach through a funnel elevated above the level of the head, and after about a quart of water has been introduced the funnel is lowered and the water, together with the contents of the stomach, are siphoned out. (See *Medicines and Treatment*, Fig. 10.) This process is repeated until the water returns perfectly clear.

This method of treatment seems at first very repulsive to the patient, but he soon becomes accustomed to the introduction of the tube, and he can then wash his own stomach out without discomfort.

There are various drugs which may also be given in the treatment of chronic gastritis, such as tincture of nux vomica and the mineral acids, but these should only be employed under the advice of a physician.

Ulcer of the Stomach.

Ulcer of the stomach is a chronic disease, in which there is an "ulcer," or little round sore, situated in the mucous membrane of the stomach. This ulcer acts just as any other sore would do: it causes pain in the stomach, and it frequently bleeds. In addition, the ulcer causes a general gastritis.

Ulcer of the stomach occurs usually between the ages of eighteen and forty, and it is more commonly found in women than in men.

Symptoms and Outlook.

The symptoms are those of dyspepsia, but *pain*, particularly upon taking food, is usually experienced, and there may be tenderness on pressure over the stomach. Vomiting of food may occur at any time, and vomiting of blood may occur from time to time. This blood is usually considerable in amount. It may be bright-coloured and clotted, or it may be black, or look like coffee grounds.

Ulcer of the stomach lasts for many months, but it may eventually be cured. It is sometimes fatal, either through excessive hæmorrhage or from *perforation* of the ulcer—that is, the ulcer eats through the coats of the stomach, and then the contents of the stomach escape from the stomach into the peritoneal cavity and cause death at once from shock, or more slowly by peritonitis.

Treatment.

The treatment should be under the direction of a physician. It is customary to put the patient on a milk diet; sometimes to feed exclusively by rectal enemata. The drug most commonly employed is nitrate of silver, as this has a beneficial effect upon the ulcer. For the relief of vomiting, bismuth, soda, and various other drugs may be given. For the relief of pain, hot or cold applications to the pit of the stomach, or a mustard poultice, may suffice. If not, various anodynes may be used; but there is always grave danger in the use of opium, for the opium habit is easily formed under these circumstances.

Cancer of the Stomach.

Cancer of the stomach is a fatal disease which attacks persons in middle or advanced age. It rarely attacks those under forty years old. It is about equally common in men and women. Its cause is unknown. It is often hereditary. The disease consists in the growth of a hard lump in some portion of the stomach—usually at the "pyloric end" of the stomach, or that end where the stomach joins the intestine.

The symptoms are for a long time those of dyspepsia, though pain in the stomach may be a particularly prominent symptom. Then the patient begins to lose flesh and strength rapidly, and the skin assumes a peculiar cancerous look—that is, it is very pale, with a light lemon-yellow shade

to it. Vomiting of food is now frequent, and there is commonly vomiting of blood from time to time. Sometimes the patient, in placing his hand over the seat of his pain, will feel a hard lump about the size of an egg, but more commonly the tumour is first felt by the physician. Sometimes the physician feels very certain that there is cancer of the stomach, but he can not prove his diagnosis because the tumour is situated at some point in the stomach where it can not be felt. The patient usually dies in about two years from the time when the tumour is first felt; but as the tumour can not be felt until it is of some size, the symptoms of cancer of the stomach last considerably more than two years.

Symptoms.

The treatment is usually only to relieve the patient and sustain his strength. The diet should be light and nutritious; often a purely milk diet is the best. Limewater, soda, bismuth, and other drugs may be given for the vomiting or like dyspeptic symptoms. For the pain, morphine must be given sooner or later, and there is, of course, no objection to its use in this disease. The surgical treatment of cancer of the stomach, either by removing the cancer or by establishing an artificial connection between the stomach and bowels, gives good results in a limited number of cases, but even under the most favourable conditions operation only prolongs life, for the cancerous disease will return either in the stomach or elsewhere.

Treatment.

Dilatation of the stomach is a chronic disease which consists in a great increase in the size of the stomach and an inflammation of its mucous membrane. It may be caused in many ways—by a cancer or other tumour partially closing the pyloric opening of the stomach, and so preventing the escape of the food into the bowels; by taking great quantities of food and drink into the stomach, as among those employed in breweries, where they drink excessive quantities of beer; by chronic gastritis; by being simply run down, and in various other ways.

Dilatation of the Stomach.

The symptoms are those of dyspepsia, with considerable loss of flesh and strength. The most characteristic symptom is the vomiting of very large quantities of partially digested food once a day, or every day or two. The stomach empties itself by this means.

The only satisfactory treatment is the regular washing out of the stomach, combined with a plain and nutritious diet. When this treatment is faithfully carried out all cases of uncomplicated dilatation of the stomach recover completely.

DISEASES OF THE INTESTINE.

Diarrhœa is the most common manifestation of disease or disorder of the intestine. In the majority of cases this diarrhœa is due to an inflam-

mation of the mucous membrane, but it may be produced by other causes than inflammation. Thus, nervous excitement will cause diarrhœa. Soldiers before going into battle are so affected; students when coming up for examination suffer in the same way; and even slighter causes will bring on an attack. Hot weather, or more commonly sudden changes from hot to cool weather, frequently cause diarrhœa. Certain articles of food, as green corn, or improper or decomposed food, may do the same thing. Drinking water, as the change to the water at the seaside, may produce it. Impure water will do the same. Inhalations of air contaminated by emanations from cesspools may cause diarrhœa. Diarrhœa is much more common among children than among adults, and it is particularly prevalent in the summer months.

Diarrhœa: Causes.

The treatment of a simple diarrhœa is, if possible, rest in bed and a fluid diet—preferably milk with a little limewater added—for twenty-four hours. If due to too much or improper food, castor oil or a few one-tenth-of-a-grain doses of calomel will carry off the offending substances and stop the diarrhœa. If due to other causes, or if there have been a number of movements, this is not necessary, and the diarrhœa may be checked by five- or ten-drop doses of paregoric for an infant, or teaspoonful doses for an adult, repeated every two or three hours.

Treatment.

Acute enteritis, or *acute inflammation of the intestine*, or *acute diarrhœa*, is an inflammation of the mucous membrane of the intestine, and it results from most of the causes already mentioned. The symptoms depend upon the portion of the bowels involved. If it be the upper portion of the bowels, there is pain in the abdomen and fever, but there may be no diarrhœa; if, as is frequently the case, the stomach is also inflamed, there is vomiting. If the lower portions of the bowels are involved, there is diarrhœa and pain, sometimes with and sometimes without fever. If the whole of the digestive tract is acutely inflamed, there is fever, vomiting, pain in the bowels, diarrhœa, and often great prostration. This latter form is known as *acute gastro-enteritis*, or cholera morbus. In children it is known as *cholera infantum*. Acute enteritis lasts several days; adults almost always recover, but it may be fatal in children.

Acute Diarrhœa: Symptoms.

The treatment depends upon the symptoms. If there be no diarrhœa, a milk diet and frequent small doses of calomel will suffice. If there be diarrhœa, rest in bed, a milk diet, and small doses of paregoric will often relieve. In other cases, bismuth in ten- to twenty-grain doses may be added, or morphine may be substituted for paregoric in adults, but morphine must not be given to children except under a physician's direction. If the pain is severe, hot poultices applied to the abdomen, or a mustard plaster, will help to relieve the pa-

Treatment.

tient. In cholera infantum the fever is often very high, and it is then important to put the little patient into a tepid or cold bath in order to reduce the temperature. If there be great prostration, whiskey should be given in five- or ten-drop doses, frequently repeated. In all cases of diarrhœa occurring in infants, change of air, especially to cooler air (as at the seashore), is desirable. I send my hospital patients down to the docks or out on the ferryboats during the heat of the day. Children should be fed only on pasteurized or sterilized milk until the diarrhœa is checked. Irrigation of the bowels by tepid water, or water containing astringents or disinfectants, is often of service.

Chronic Diarrhœa.

Chronic enteritis, or *chronic diarrhœa*, may result from an acute enteritis, or it may be due to a variety of other causes. It is very common in prisons and among soldiers as the result of improper hygiene. It occurs among the delicate and sickly. It may be caused by consumption, owing to the tubercular inflammation of the bowels. It may result from chronic heart disease, or disease of the liver or the kidneys. There may be only a catarrhal inflammation of the mucous membrane of the bowels, but very commonly there are little ulcers all through the mucous membrane of the bowels. The disease lasts a long time and is difficult to cure.

The symptoms are diarrhœa (from two to ten movements in the twenty-four hours, alternating with constipation); there is pain in the bowels and loss of flesh and strength. The treatment is strict attention to the laws of health, a carefully selected diet, change of air, and various drugs for the relief of the diarrhœa, such as bismuth, tannic acid, the mineral acids, or nitrate of silver.

Dysentery.

Dysentery, or *bloody flux*, is an inflammation of the lower bowel which is characterized by frequent small passages containing blood and mucus (or slime, as it is commonly called), and attended by a straining pain in the rectum at the time of the movement.

Dysentery may be either acute or chronic. In the *acute form* there is usually only an inflammation of the mucous membrane of the rectum or lower bowel. In the chronic form there are ulcers throughout the rectum and colon. Dysentery may occur at any age, but it is rather more common in adults. It is particularly a disease of hot countries, though it may be found throughout the whole world. It is most prevalent in summer and autumn. Sudden changes of temperature are conducive to dysentery, and imperfect hygiene and improper food are also conducive to the disease. It is very prevalent among soldiers in camp. It may be due in certain cases to a specific germ called the *Amœba coli*. Dysentery may occur in isolated cases or it may occur in epidemics.

Both the duration and the severity of acute dysentery vary within

considerable limits. It may last from two or three days to three weeks. The patient may be so slightly sick that he does not go to bed, or the attack may be so severe that he dies within forty-eight hours from the initial symptoms.

Chronic dysentery lasts for months or years. The patient may be finally worn out by the disease and die, or he may die of some intercurrent disease.

Treatment.

The treatment of acute dysentery is rest in bed, fluid diet, the use of bismuth or opium to check the too frequent movements of the bowels, or the combination of small doses of opium and small doses of castor oil frequently repeated to produce regular and healthy movements of the bowels.

The treatment of chronic dysentery is practically the same, except that rest in bed is not required. Much can be gained by frequent irrigation of the bowels by water containing astringents or disinfectants. A person suffering from either acute or chronic dysentery should always be under the care of a physician.

Constipation.

Constipation is a condition in which the fæcal matter is retained in the bowels too long, or in which the expulsion of the fæcal matter is attended with difficulty. With most persons a natural movement of the bowels once a day is the regular thing. Some have two natural movements a day—one in the morning and one at night. A few individuals are accustomed to go two or more days without any movement of the bowels and suffer no inconvenience from this prolonged retention of fæces.

Constipation usually causes a good deal of discomfort. The abdomen feels full, and it may be swollen; there may be nausea; the tongue is coated and the appetite lost; there is an unpleasant odour of the breath there is headache, listlessness, and depression of the spirits. All these symptoms are relieved when the bowels are moved.

Constipation may be present from infancy or it may come on at any time. It is particularly common among women and among those engaged in sedentary occupations.

Treatment.

The treatment of constipation is to avoid any form of medicine if possible. The best way is to have a definite hour for going to stool and to go regularly day by day at that hour, and to sit there quietly without straining until the bowels move spontaneously, no matter how long it takes. Once the habit is formed, there is usually no further trouble with the constipation. If this is not the case, sufficient active muscular exercise will be of great value. Massage of the abdomen will also help. The diet should not be too concentrated, vegetables in particular being eaten freely. Fruit should also be freely eaten. Stewed prunes are considered very efficacious. Two or

three figs at bedtime will often move the bowels the next morning. A glass of ice water before breakfast will often stimulate the bowels to move immediately after breakfast.

If medicine must be used, any of the laxative mineral waters may be taken before breakfast, or a laxative pill may be taken at bedtime. The drugs usually employed in laxative pills are cascara, nux vomica, ipecac, and extract of colocynth. If the bowels move with difficulty, an injection of soap and water will soften the fæces and give a painless evacuation.

Intestinal Parasites.

The most common forms of *intestinal parasites* or *worms* are the tapeworm and the roundworm. The former may be very long—many feet—and usually only a few links or segments are discharged at a time, the head remaining attached to the mucous membrane of the intestine and the segments growing from it. The roundworm is about three inches long, and often several are discharged at once.

The symptoms of the presence of worms are digestive disturbances, nervousness and restlessness, picking of the nose and rolling the head, and grinding the teeth at night. It must be remembered that these symptoms may all be due to other causes than the presence of worms, and that the only certainty of their presence is to see them in the fæces.

Treatment.

The treatment of tapeworm is to expel the head. To effect this the intestine is rendered as empty as possible by fasting for twenty-four hours or by a light diet for two days. Then in the morning a half teaspoonful of oleoresin of male fern is administered, the patient continues to fast during the day, and in the evening a full dose of castor oil or of calomel is administered.

The roundworm is dislodged by the administration of santonin. One grain of santonin and one grain of calomel may be given in powder to a child five years old every three or four hours until the bowels are moved.

Threadworms or seat worms are little thread-like worms which infest the rectum. They are best removed by injections of limewater.

DISEASES OF THE LIVER.

Jaundice.

Jaundice is a yellow discoloration of the skin and other tissues of the body caused by some mechanical impediment to the discharge of the bile into the bowels. The bile accumulates in the liver, and is then absorbed by the blood, and is carried by the blood to all the tissues of the body. In a few cases jaundice is caused by changes in the system as a whole, and not by mechanical obstruction to the flow of bile. This is seen in poisoning by phosphorus or by snake bites. It is occasionally observed in connection with pneumonia and with some forms of liver disease.

Catarrhal Jaundice.

By far the most common form of jaundice is what is known as "catarrhal jaundice." Here the little opening of the common bile duct into the small intestine is closed by the swelling of the mucous membrane of the small intestine due to the catarrhal inflammation of the upper part of the intestine and, usually, of the stomach also—*gastro-duodenitis* we call it.

The symptoms are a slight feeling of indisposition, some dyspeptic symptoms, constipation, perhaps a little fever, and then the skin and the mucous membranes become yellow, the urine also becomes yellow, and the fæces dry and clay-coloured. Very often there is itching of the skin. These symptoms last from two to three weeks and then the patient recovers perfectly.

The treatment is to be careful in the diet and keep the bowels open by calomel or other gentle laxatives. Bicarbonate of sodium in moderate doses frequently repeated is the best drug to diminish the jaundice. Good results are also obtained by the daily injection of one or two pints of ice water into the rectum.

Biliary Colic.

Jaundice may also be caused by the lodgment of a "gallstone," or a little solid biliary concretion, in the common bile duct, thus preventing the escape of bile into the intestine. Such a condition is commonly known as *biliary colic*, or "the passage of a gallstone."

The patient is suddenly taken with intense pain in the right side just below the ribs and on a line with the nipple. The pain usually runs up to the right arm and there is frequent vomiting and considerable prostration. The attacks of pain come and go for a certain number of hours and then intense jaundice appears. This jaundice lasts a variable length of time—that is, until the gallstone has worked its way through the common duct and been discharged into the intestine. If the gallstone does not enter the common bile duct there will be the symptoms of biliary colic for a long time but no jaundice, because the bile is not prevented from escaping.

The treatment of biliary colic is to put the patient at once into a hot bath, administer morphine hypodermically, or give chloroform by inhalation. The administration of large quantities of sweet oil—half a pint or a pint—by the mouth will often facilitate the passage of the gallstone.

Jaundice may also be caused by the pressure of a cancer or other tumour upon the bile ducts. Here the jaundice is permanent.

Hardening of the Liver.

Cirrhosis of the liver, hardening of the liver, or *gin drinker's liver* is a chronic disease of the liver in which the liver becomes incapable of properly performing its functions. The size of the

liver is usually considerably diminished, but sometimes it is so increased that the patient himself can feel a distinct swelling in the abdomen.

The disease is most frequently caused by the slow poisoning of the system by alcohol. Those who constantly indulge in several drinks of spirits in any form each day, even though they are never intoxicated, are liable to cirrhosis. The disease may be caused by other conditions than the abuse of alcohol, such as syphilis, or from gallstones which have been lodged in the bile ducts for a long time.

The symptoms are a slow and progressive loss of flesh and strength, dyspepsia (especially morning vomiting or nausea), and frequently dropsy of the abdomen. With the large form of cirrhosis of the liver there is sometimes intense jaundice. This is a serious symptom. Often disease of the kidneys is associated with cirrhosis of the liver. Sometimes patients die from the cirrhosis within two or three years; others (especially if they stop the use of alcohol) live many years.

Treatment.

The treatment is to stop the drinking of alcohol altogether, and to regulate the diet and build up the system. If there is disturbance of the stomach, appropriate drugs may be taken to correct this condition. If there is dropsy of the abdomen the fluid may be removed by increasing the action of the kidneys and bowels by the proper drugs, or the fluid may be mechanically removed by tapping the abdomen.

Cancer of the Liver.

Cancer of the liver is usually secondary to a cancerous growth of some other organ, as the intestine or stomach. Rarely there may be cancer of the liver without involvement of other organs.

The symptoms are those common to cancerous disease, and in addition there is pain and tenderness over the liver, and frequently enlargement of the liver, so that the patient may feel the enlargement in the abdomen. There may be intense and permanent jaundice.

The treatment is only palliative. It is a certainly fatal disease.

Abscess of the Liver.

Abscess of the liver is a disease in which there is found one or more collections of pus (or matter) in the substance of the liver. It is a disease which if untreated lasts a long time, and finally terminates in death. If discovered and treated in time a large proportion of the cases recover perfectly.

Abscess of the liver may occur in any part of the world, but it is most prevalent in tropical countries. It is frequently found associated with or following dysentery, in which case the abscess is caused by the same living organism which caused the dysentery. This organism is called the *Amœba coli.*

The symptoms of abscess of the liver are often very indefinite. The patient feels sick, he has fever, and he loses flesh. If there be no other

symptoms than these, and if there be no enlargement of the liver which the physician can discover, it may be impossible to make a diagnosis. In other cases, in addition to these symptoms, there may be a very high and intermittent temperature, with chills and sweating; there may be pain and tenderness over the region of the liver, and the enlargement may be so considerable as to be readily recognised by the physician.

Symptoms and Treatment.

The treatment is to remove the pus by aspiration, or by making a good-sized opening through the chest or abdominal wall and introducing a drainage-tube into the abscess cavity.

DISEASES OF THE PANCREAS.

The pancreas lies very deep in the abdominal cavity—just below the stomach. Its office is to assist in the process of digestion, particularly in the digestion of fats.

Diagnosis.

Diseases of the pancreas are not common, and are always difficult of diagnosis. Disease may be suspected if there is pain in the upper part of the abdomen, together with the presence of fat in the stools and sugar in the urine. It must be remembered, however, that fat may be present in the stools if taken into the stomach in excess, and that diabetes may be due to other causes than disease of the pancreas. Diseases of the pancreas are, however, often present without any of these signs, and then the diagnosis can not be made with any degree of certainty.

DISEASES OF THE SPLEEN.

The spleen is a solid organ about the size of a flattened orange. It is situated on the left side of the abdomen and beneath the lower side, so that in health it can not be felt. Its chief function is in connection with the elaboration of the blood.

Enlargement.

The spleen is subject to a number of diseases which result in its enlargement to such a degree that it can be felt by the patient, or which may even cause great enlargement of the abdomen. Malarial poisoning causes an enlargement which is often very great and which may last a long time. This is commonly known as an "ague cake." Leukæmia, or a disease of the blood which consists in a very great increase in the white corpuscles of the blood, is attended by very great enlargement of the spleen. Diseases of the liver, especially cirrhosis of the liver, cause a more moderate enlargement of the spleen. Many infectious diseases—notably typhoid fever—are attended by enlargement of the spleen. The spleen may be dislocated or be displaced from its proper position, and then it becomes congested and enlarged, and remains so until it is replaced and maintained in its proper position.

The treatment of enlargement of the spleen is of the disease which leads to the enlargement.

DISEASES OF THE PERITONÆUM.

Peritonitis.

The peritonæum is the delicate membrane which lines the abdominal cavity and covers all the organs in the abdomen. It is very sensitive and very intolerant of any irritation, so that a very slight cause may set up a widespread and fatal inflammation of the peritonæum.

Acute Peritonitis.

Acute peritonitis may be caused in many ways, but perhaps the most common is by extension of the inflammation from the vermiform appendix, or by "appendicitis," as we call it. Inflammations of other organs may spread to the peritonæum, or peritonitis may be caused by a perforation of an ulcer in the stomach or in the intestines, or by a blow upon the abdomen, or by surgical operations upon the abdominal cavity.

The symptoms are pain in the abdomen, vomiting, constipation, distention of the abdomen, great prostration, fever, and a rapid and feeble pulse. There is commonly a peculiarly drawn and anxious expression of the face.

The disease is always serious and frequently fatal. The treatment is by rest in bed, the application of cold to the abdomen, and opium. A physician should be called at the earliest possible moment.

Chronic Peritonitis.

Sometimes an acute peritonitis, instead of terminating in recovery, passes into a chronic stage, which lasts for a long time; in other cases the inflammation of the peritonæum is chronic from the beginning. In this latter form we have a condition entirely different from acute peritonitis. It occurs most commonly in children, and more frequently in girls than in boys.

The symptoms are pain in the abdomen, diarrhœa alternating with constipation, emaciation, occasional fever, and a gradual distention of the abdomen with fluid, so that the case resembles abdominal dropsy, or an abdominal tumor, such as an ovarian cyst. Frequently there is but little pain, emaciation, or fever—the enlargement of the abdomen is the prominent feature.

Most of these patients recover, although months may elapse before the abdominal swelling disappears.

The treatment is to build the patient up in every possible way. Now, quinine and arsenic in small doses is of service. Frequently it is found necessary to puncture the abdominal wall and draw off the fluid in that way.

Tubercular peritonitis is a chronic inflammation of the peritonæum, which is caused by the tubercle bacillus. In tubercular peritonitis there

is always some previous tubercular infection in some other part of the body, such as the lungs or the genital organs, but the inflammation of the peritonæum assumes such prominence that the primary inflammation is of little consequence, and is, in fact, often overlooked. The disease is most common between the ages of twenty and forty, and it attacks both sexes.

Tubercular Peritonitis.

The progress of the disease is slow, and, of course, in a large proportion of the cases a fatal termination is to be expected.

The symptoms are similar to those of chronic peritonitis, but more marked. There is more pain in the abdomen, the emaciation is much greater, and the fever more constant and more intense. But there may be little or no fever. There is generally swelling of the abdomen, due in part to distention of the intestines with gas, in part to fluid in the abdominal cavity.

The treatment is similar to that for chronic peritonitis. Laparotomy, or opening the abdominal cavity by an incision of some size, has been followed by complete recovery in a number of cases, but there is some doubt as to whether these were cases of tubercular peritonitis or of chronic non-tubercular peritonitis.

IX.

DISEASES OF THE KIDNEYS AND URINARY DERANGEMENTS.

By J. WEST ROOSEVELT, M. D.

INTRODUCTION.

The kidneys are subject to a large number of diseases which more or less endanger life. It is impossible within the limits of this article even to mention the rarer affections of these organs, and I have made no effort to do more than sketch in outline some of the most important and most common. I have made no effort to describe the details of the morbid changes which occur in the glands; it would be impossible to do so in a way which would be comprehensible to a layman. Moreover, so much doubt and confusion exists in the minds of medical men in regard to the causes of many of the symptoms of kidney disease that I have confined myself principally to a simple account of what the main symptoms are without trying to explain why they are. I hope that I may succeed in giving a fairly complete and accurate practical account of kidney disease, which can be understood without too much trouble.

BRIGHT'S DISEASE.

Characteristics.

A certain group of diseases characterized by lesions of the kidneys and often associated lesions of other organs are commonly called Bright's disease. The term is rather unfortunate; but it can not yet be abandoned. These diseases have something in common, and it is as yet impossible entirely to separate them, clinically at least, from one another. In all of them there is more or less destruction, temporary or permanent, of the kidney structure. Almost invariably both kidneys are affected. The lesions may affect only the secreting cells, or all of the structures of the kidney. They seem all to be caused by something which affects primarily the system at large, and secondarily the kidneys. The poisons which may cause these lesions are probably numerous and have not yet been discovered, nor has their mode of action been entirely explained.

It is needless to attempt to describe in detail the numerous classifications which have been attempted, and I shall content myself with a brief account of what I shall call acute Bright's disease and chronic Bright's disease. This classification is sufficiently accurate for the purposes of this book.

GENERAL CAUSES OF BRIGHT'S DISEASE.

Geographical Distribution and History.

Bright's disease is mainly confined to temperate climates. It is not common in the tropics or the arctic regions. In general it may be said that the acute forms and the group of more chronic cases which are characterized by a pretty rapid course, with marked dropsy, are diseases of childhood and early manhood, while the cases with the atrophic kidney belong to more advanced life.

Exposure.

Exposure to cold and wet is thought to cause some acute cases if the exposure is severe and sudden, as, for example, a night spent in the cold and wet. It is also thought by some authors that similar but not so great exposure frequently repeated may predispose to the chronic forms—a statement open to doubt.

Infectious Diseases.

Various infectious diseases, especially scarlatina, diphtheria, and yellow fever, are apt to be followed by an acute form of Bright's disease. It is stated by some authors that in scarlatina the lesion of the kidneys is brought about by the skin lesion of that disease. The skin not being able to perform its functions owing to the changes in it caused by the scarlatinal poison, the kidneys become diseased because of the extra work thrown upon them. This is not the true explanation in all cases, however. The kidney disease caused by other acute infectious diseases is usually considered to be an effect upon the kidneys of the disease poison. Cholera produces a disease of the kidneys of which patients often die. In this case it is thought that the thick blood found in the stage of collapse in cholera can not traverse the renal capillaries rapidly enough; that much the same condition obtains as when a renal artery is partly compressed. When reaction occurs and the blood again flows freely, the nutrition of the kidney having suffered from the slowed current, acute Bright's disease ensues.

Organic and Inorganic Substances.

Various organic and inorganic substances may produce acute or chronic Bright's disease. Such are arsenic, phosphorus, carbolic acid, etc.

The effect of alcohol in producing Bright's disease, either acute or chronic, is not perfectly clear. Chronic drunkards, it is true, often have chronic Bright's disease, but many also have it who have lived a temperate life, and we do not find it in every drunkard.

Certain cases seem to be due to hereditary influence. It is not uncommon to find two or more of the same generation of a family affected with chronic Bright's disease, and in some families it has passed through several generations, one after another dying of it. Gout seems to cause certain cases, and gout is certainly hereditable.

Heredity.

THE RELATIONS OF HEART AND KIDNEY DISEASE.

Many cases of chronic Bright's disease are associated with hypertrophy of the heart. In some cases we find with the hypertrophy some valvular lesion and sometimes dilatation. On the other hand, many cases of valvular heart disease cause a peculiar lesion of the kidneys. We have, then, two sets of cases—those in which the heart lesion is primary, and those in which either the renal lesion precedes the cardiac or, at least, the changes in the heart and kidneys occur at nearly the same time and as a result of the action of the same poison.

HEART DISEASE COMPLICATING BRIGHT'S DISEASE.

Heart disease complicates certain forms of chronic Bright's disease. Various explanations have been offered of this coexistence of cardiac hypertrophy (enlargement of the heart) and Bright's disease. Perhaps the most satisfactory is that which ascribes it to high arterial pressure. In most, if not all, cases of chronic renal disease in which hypertrophy of the heart occurs there is marked elevation of the blood pressure in the arteries, showing itself by the long, slow, full, strong pulse. This rise of pressure is thought to be caused by spasm of the arterioles or capillaries throughout the body, due to some poison in the blood, which prevents the free passage of the blood through these vessels. In order to force the blood past this increased resistance the heart must do more work than usual. Now, one of two things may occur: either the heart may hypertrophy and, by becoming stronger, may overcome the resistance, or it may not hypertrophy, but continue to try to do the increased work, liable, however, to fail at any time when a little increased strain is thrown upon it. This is the probable cause of heart disease in most cases. It is needless to speak of others.

HEART DISEASE PRODUCING BRIGHT'S DISEASE.

Valvular disease of the heart causes a form of Bright's disease by inducing a passive venous congestion of these organs. The other causes of chronic congestion of the kidneys have been considered. In valvular cardiac disease, no matter of what form, we have the veins too full and the arteries too empty. The kidneys share in this congestion.

APOPLEXY.

Apoplexy, or hæmorrhage into the brain, occurs in a number of cases of chronic Bright's disease, especially in those with the atrophic kidney. The hæmorrhage may be large or small. Not infrequently it is the cause of death. The frequency of cerebral hæmorrhage in Bright's disease is not surprising when one remembers that in many cases we have high blood pressure, a strong heart, and more or less diseased vessels—conditions most favourable to cause rupture of a vessel and consequent hæmorrhage. Disease of the cerebral vessels is often very pronounced in Bright's disease.

CIRRHOSIS OF THE LIVER AND EMPHYSEMA OF THE LUNGS,

with bronchitis, often occur with Bright's disease.

INFLAMMATORY COMPLICATIONS.

Inflammations of Serous Membranes.

Cases of chronic Bright's disease are often complicated by inflammations of serous membranes. Pericarditis and peritonitis in an acute form sometimes occur. Chronic meningitis occurs quite frequently. Bronchitis, pneumonia, and pleurisy are frequent complications.

Phthisis.

Patients with chronic Bright's disease, like those with diabetes, seem often to offer a suitable soil for the growth of the tubercle bacillus. Phthisis is rather commonly found associated with renal disease. In some cases phthisis *produces* a form of disease of the liver, spleen, and kidneys, but it is not infrequently found with the other forms of renal disease, and seems to follow them.

URÆMIA.

Meaning of the Term.

Acute uræmia is a term applied to a group of dangerous symptoms which may arise in the course of Bright's disease. The kidney disorder causing acute uræmia may itself be either acute or chronic. It is customary with many authors to speak of chronic uræmia as distinct from the acute form. This is for medical men a proper distinction, but for this book it is needless to make it. Whenever the term uræmia is used hereafter the *acute* form is intended to be understood.

Symptoms.

The following are the symptoms of acute uræmia: Headache, confusion of mind, drowsiness, stupor (which may deepen into coma), convulsions, dimness of vision, nausea, vomiting, difficulty in breathing, diminished or suppressed urine. The headache may be mild, but is usually severe. It comes on suddenly in many cases, and soon is followed by a certain amount of drowsiness or

stupor. When it first begins, however, the patient is usually nervous and restless, and acutely sensitive to noises, and is, moreover, apt to be cross and irritable. Sometimes there is delirium instead of stupor.

Nausea and vomiting usually precede or follow the onset of the headache. Vomiting, indeed, is frequently the first symptom observed. There is sometimes, though rarely, diarrhœa. The skin is apt to be dry and the bowels constipated. There is usually some fever.

After a few hours or days the patient either becomes comatose (completely insensible) and dies in this state; or general severe convulsions occur, in which the violent twitchings of the muscles toss the body about in a hideous way. It is important for those whose fate it is to see such convulsions to bear clearly in mind the fact that there is absolutely no suffering connected with them so far as the patient is concerned. There can be no doubt of the truth of this assertion, for patients who survive these attacks invariably tell us that they have had no knowledge of their occurrence.

Sometimes dimness of sight, or even complete blindness, ushers in an attack of uræmia, and it is seldom that some eye symptoms are absent.

When uræmia occurs the patient is in a state of immediate and great danger. He may die in the first convulsion, or may survive a large number and finally recover, but it is imperatively necessary to call for competent medical aid as soon as the first symptoms appear.

ACUTE BRIGHT'S DISEASE.

Causes.

Acute Bright's disease is caused by various diseases in which fever is present. It occurs in some cases of pneumonia, typhoid and typhus fevers, measles, smallpox, and various other acute diseases. It is a frequent and dangerous complication of scarlet fever and diphtheria. A form of it often follows the stage of collapse in cholera, and is one of the causes of death in this disease, carrying off the patient when he seems to be on the road to recovery. There are a number of poisons which produce acute inflammation of the kidneys. Among these may be mentioned arsenic, phosphorus, corrosive sublimate, chlorate of potash (in large doses), carbolic acid, turpentine, preparations made from the Spanish fly (cantharides), and certain other drugs which it is unnecessary to enumerate in this connection. In some instances exposure to cold and wet seems to bring on acute Bright's disease; and there are not a few cases the causes of which are entirely unknown.

Lesions.

The kidneys are found to be acutely inflamed, and there is often more or less dropsy. The blood is pale and thin. There may be acute inflammation of various organs besides the kidneys.

It is well to give a brief outline of what may be called a typical case, and then to consider the symptoms in a more detailed way.

Typical Case.

A young adult, previously healthy, after having been exposed to cold and wet for a number of hours, begins to feel weak and ill. He has aching pains in his limbs, and perhaps some pain and tenderness in the loins. He has slight headache and his pulse is rapid, his temperature above normal. His appetite is gone. His urine is much diminished in amount, is of nearly normal specific gravity, and contains a good deal of albumin, a little blood, and a few hyaline and granular casts. In a short time the patient begins to suffer from nausea and vomiting. Dropsy soon appears, and involves usually first the feet or the face. In a few days it becomes general, the whole of the subcutaneous tissue being involved. The skin becomes white and waxy. Headache may now begin to be complained of a good deal. Perhaps the vision becomes dim. Sleep may be poor, but the patient feels drowsy. The nausea and vomiting may by this time have become very distressing symptoms. During all this time the quantity of the urine has varied a good deal—sometimes it has been diminished, sometimes increased. At the end of two or three weeks it begins to increase decidedly; the patient passes two or three quarts a day. The dropsy now begins to diminish; sleep improves; the headache passes off; nausea and vomiting disappear. At the end of another fortnight the patient is left pale, thin, and weak, but with no other symptoms. The urine may be albuminous for some months afterward.

Instead of this termination, the headache may become very severe and the patient gradually become more and more drowsy, and finally die comatose or in convulsions. On the other hand, it is not at all uncommon to have no uræmic symptoms at all; the patient, except for the dropsy and weakness, may feel perfectly well a few days after the onset. He may have a good appetite and be free from any discomfort save that produced by the general dropsy.

The urine is diminished in quantity and may be suppressed. Its specific gravity is lowered and the amount of urea is lessened. There is a large amount of albumin; sometimes the urine becomes solid upon boiling. Its colour is usually darker than normal, and it may be almost black from the presence of blood. Granular matter, blood, epithelium of various types, pus cells, and granular, hyaline, epithelial, and blood casts may be found in abundance. If the disease has lasted for some time, fatty casts may be present. The amount of blood varies greatly in different cases, and it may be absent.

Symptoms.

The onset varies in different cases. In some it is abrupt, with rigours, frequent and painful micturition, diminished amount of urine, marked pain in the loins, and severe cerebral symptoms from

the start. In others it is more gradual; the patient only feels rather out of health, becomes pale, and has some disturbance of the stomach. Then dropsy sets in, with loss of flesh and strength. Such cases are not apt to be so severe as the first.

Disturbance of the Circulatory System and Respiration.

Dropsy is present in a large number of cases. Anæmia soon becomes very marked. The pulse may be weak or strong. At the onset it is often very hard and incompressible. Some of these patients suddenly develop a rapid, weak pulse with full vessels and dyspnœa, and die in a few days or hours from acute dilatation of the heart (Goodhart). These patients may also die suddenly of syncope. Shortness of breath is often a marked feature. It is sometimes due to dropsy of the chest and pressure upon the lungs, sometimes to dropsy of the lungs, and sometimes its cause is unknown.

Disturbance of the Alimentary Canal.

In a majority of cases there is loss of appetite and severe nausea and vomiting. The vomiting often occurs without any apparent relation to the ingestion of food. It may, however, only occur after food has been taken. The tongue is usually coated. If insensibility or great stupor occur, it becomes dry and brown.

Disturbance of the Nervous System.

As has been said, some cases do not show marked nervous symptoms. In many, however, these are severe. We have drowsiness, restlessness, delirium, stupor, or even coma and convulsions. There may also be partial or complete blindness, usually without change in the retina, and probably, therefore, of cerebral origin. Some patients complain of dizziness.

The temperature is elevated in many cases at first. After the onset it may become normal, but if acute uræmia supervene it rises again. (See *Uræmia.*)

Loss of flesh and strength are apt to be marked after the disease has lasted for some time.

Duration: Several weeks or months.

Terminations: Complete recovery; apparent recovery, in which the urine does not return to the normal and relapses occur, the disease becoming chronic; death.

Causes of Death: Acute uræmia, syncope, or more gradual heart failure. Some complication.

Prognosis.

The prognosis varies much in different cases. In children the prognosis is better than in adults. Suppression of urine for twenty-four hours is a very grave symptom. Convulsions may cause sudden death, although they may also pass away. Deep coma is very grave, and well-nigh hopeless.

In the cases with an acute onset, where there is immediate danger to

life, the treatment must be directed toward combating the nervous symptoms. For this purpose morphine is very valuable. It calms the nervous centres and encourages the action of diaphoretics. Chloroform or chloral are preferred by many authors. It is customary to give hydragogue cathartics and to induce sweating. Of course the patient will be put on a liquid diet and kept quiet in bed. During the earlier stages it is often of use to give some form of purgative, like calomel or Epsom salts (sulphate of magnesia)—*not in large doses*, however, but in small, repeated ones. The application of counter-irritation (cups or mustard) over the loins may do good. Hot-air baths (see *Medicines and Treatment*) are useful in some cases. The disease is not one which can be treated with much prospect of success save by a good physician. Various cases differ so much, one from another, that the greatest skill (which can be obtained only from experience) is required in order to deal with any but the mildest. It must be remembered that while some cases are almost certain to recover without treatment, and that some will die in spite of it, a large number remain which may be killed by neglect or bad treatment, or cured by *skilful*, early attention.

Treatment.

CHRONIC BRIGHT'S DISEASE.

Cases of chronic renal diseases, regarded from an anatomical standpoint, may be divided into two classes: 1, those in which the most prominent lesions are epithelial and the kidneys usually enlarged; 2, those in which the kidneys are small and the stroma (framework or interstitial tissue) and vessels show the most marked changes.

Clinically, a sharp division of the different classes is impossible. In some cases with large kidneys we have symptoms identical with those usually produced by small kidneys, and *vice versa*. In the following pages I shall attempt to describe the symptoms and course usually to be expected with the different forms, but I admit that in many cases a differential diagnosis is impossible. There are, however, such great differences in the symptoms *usually* produced by the two anatomical forms of kidney disease that it is best to deal with them separately.

THE LARGE KIDNEY.

The large kidney is a form of chronic Bright's disease in which the kidneys are increased in size and the course usually rapid. The disease is more frequent before than after middle life. Males are more frequently attacked than females. The disease is said to be rarely seen save in temperate climates. Alcohol is thought to be the exciting cause in some cases. Others occur as sequels to acute outbreaks. Some authors are inclined to attribute to cold, or rather to

Causes.

alternations of heat and cold, an important part in the ætiology. In a large number of cases careful search fails to show any recognisable cause.

Symptoms observed in a Typical Case.

A young adult observes that he is not feeling well. He is pale, easily tired, his stomach is easily upset, perhaps he has some breathlessness on exertion. He loses flesh a little. After a while dropsy appears, and in a few weeks has become general. He suffers from headache and sleeps badly. His appetite goes almost completely. His bowels are sometimes confined; sometimes he has diarrhœa. Anæmia becomes very pronounced. After a time his eyesight grows dim; he may even become blind. During all this time his urine is diminished. He may have attacks of dyspnœa. The pulse is often one of high tension; after a time hypertrophy of the heart may be observed. After several months or a year, if the case continues to progress badly, as it usually does, the patient may pass into a typhoid state and die; or acute uræmia may set in, and he may die in coma or convulsions. Sometimes the patients die suddenly; sometimes they seem to die from the mechanical effects of the dropsy; sometimes an acute inflammation kills them. All the symptoms may undergo improvement for a time and then again become worse.

Disturbance of the Alimentary Canal.

Dropsy is usually developed early, and may be the first symptom. It is sometimes slight and confined to the face and legs, but more often it is general and severe. It is rare not to have any with the large kidney. Loss of appetite, nausea, and vomiting are usually present at some time in the disease, and may be the first symptoms. Diarrhœa is not unusual, and is sometimes profuse and exhausting.

Disturbance of the Circulatory and Respiratory Systems.

The pulse is usually long, slow, full, and strong. Hypertrophy of the heart is found in a fair proportion of cases, but it is not as frequent as with the atrophic kidney. Palpitation of the heart and dyspnœa on exertion are common. The patients may also suffer from true renal asthma, or from dyspnœa due to the dropsy. Anæmia is pronounced.

The temperature often rises during uræmic attacks, but no rise of temperature seems to accompany the disease except during these outbreaks, or as a symptom of some complication.

Disturbance of the Nervous System.

Headache, slight or severe, is frequent. Neuralgia, especially of the fifth and sciatic nerves, occurs with some cases. Colic is quite common. Blindness, partial or complete, occurs in some cases, with or without lesions of the retina. Sleep is often poor and interrupted by dreams. In advanced cases there may be stupor, delirium, coma, or convulsions, or the condition known as the typhoid state.

The patients lose flesh and strength in a marked degree. The cases frequently die within a year or two after the first symptoms are observed.

Course and Duration: Causes of Death.

The symptoms may, however, intermit for a considerable time and then recur, so that it is possible for a patient to live for ten years or more, having had several attacks, with intervals of pretty good health. Some patients die very suddenly, apparently of syncope; some of uræmic coma or convulsions; some of exhaustion; some from the effects of the dropsy; some of phthisis, or other complicating disease.

Prognosis.

The prognosis or outlook is serious. Some few of the cases seem to recover entirely. Frequently, as has been said, the recovery is only apparent and relapses occur.

Treatment.

The plan of treatment to be pursued is calculated partly to relieve the kidneys of part of their work, partly to remove troublesome or dangerous symptoms, partly to build up the patient's strength. At the beginning it is well to put the patient to bed and enforce absolute bodily and mental rest. A milk diet should be tried. If there are no urgent symptoms this is all that is needed for a while. If dropsy is excessive, measures may be adopted for its relief. Catharsis may be tried—a fairly large dose of some saline, for example, every day or two for a time. The skin may be improved and sweating induced by a bath of hot air, vapour, or water. Some patients improve under a course of sweating, but some are exhausted by it, in which case it must be abandoned. Diuretics—digitalis, squills, or other drugs, and especially water—seem to be of service at times. If extensive ascites (dropsy of the abdomen) or a dangerous amount of hydrothorax (dropsy of the chest) be present, the patient may be tapped or aspirated. Sometimes much good comes from draining off the fluid by means of a number of punctures in the legs made with a clean sharp needle. If troublesome vomiting occur, iced milk and limewater in small amounts, or carbonic-acid water with milk, or bicarbonate of sodium, may relieve it. Diarrhœa, if it be not excessive, may be actually of service to the patient. If it becomes profuse and exhausting, astringents, bismuth, and other remedies may be tried. Patients with this form of diarrhœa do not usually bear morphine well. On the other hand, when acute uræmia with marked cerebral symptoms is present, morphine is often well borne and of service. Headache with high arterial tension may be relieved with chloral. Uræmic convulsions may be treated with morphine, chloral, or chloroform.

General tonics are indicated. Iron is often very useful. After the more severe symptoms have subsided, residence in a warm climate is greatly to be desired.

THE SMALL KIDNEY.

The small kidney is a form of chronic Bright's disease and differs from the one which has been described in many ways. It is usually much more chronic in its course. Its onset is insidious. It usually occurs after middle life. In it the kidneys are reduced in size and there is great increase in the fibrous tissue in them. Cardiac hypertrophy is more common with this than with the large kidney. So also is apoplexy. The lesions of cirrhosis of the liver and emphysema are present with it in a large number of cases.

Causes.

It is a disease of temperate climates and affects ordinarily persons more than forty years old. Cases are on record, however, in which it has been found in children. Some cases seem to be hereditary. For a certain number no cause can be assigned. The subjects of this disease are often people who use alcohol to excess. Gout, which is certainly hereditary, seems to produce some cases. Chronic lead poisoning produces others. Occupations involving much exposure to severe changes of temperature, such as iron-working, etc., seem to favour the disease.

The urine in the earlier stages is usually increased in amount (two to four). Its specific gravity is lowered (1005 to 1015), its colour pale. Sometimes the passage of a large amount of urine alternates with the passage of a smaller quantity. Albumin at first is absent or present only in small quantity. Casts also are not abundant and are hyaline or granular. As the disease advances the amount of urine often diminishes. It may toward the end be suppressed. The quantity of albumin usually increases much as time goes on, and casts become more numerous and of greater variety, and perhaps blood may be found. There are cases in which no albumin is found at any time, and many cases in which several examinations may be made before it is found. The specific gravity of the urine in such cases becomes a useful help in the diagnosis. Even in cases without albumin the microscope may show casts. In a case where this lesion is suspected, a number of careful, thorough chemical and microscopic examinations should always be made.

Symptoms.

The onset is usually insidious. It is often impossible to say how long the disease has lasted before the patient comes under observation. The earlier symptoms vary much. Sometimes a patient complains that he has to get up at night several times to pass water, and that he passes a great deal. At other times anæmia, with loss of flesh and strength, first causes anxiety. Dyspepsia with perhaps vomiting, or vomiting alone without dyspeptic symptoms, is occasionally the first complaint. Some patients are troubled with constant headache. Some first are troubled with sleeplessness. Some notice slight œdema of the ankles in the evening. Others find their sight failing, and an ex-

amination shows advanced neuro-retinitis (inflammation of the optic nerve). Occasionally severe neuralgia first directs attention to the kidneys. An attack of spasmodic dyspnœa occurring in a person not formerly the subject of asthma may be the first symptom noticed. Palpitation of the heart on exertion first troubles certain patients. Sometimes renal symptoms first appear after some more or less severe injury has prostrated the patient. In a few cases uræmic coma and convulsions occur suddenly in patients who were before thought to be well. Certain people are stricken with apoplexy who have diseased kidneys, yet have not shown symptoms before. In a certain number of cases no symptoms are observed during life, and yet an autopsy shows marked renal lesions. Sometimes the disease is first discovered during the course of an examination, undertaken for some special reason, as, for example, life insurance, where its existence has not been suspected.

Although the onset is usually insidious, certain cases seem to begin acutely. In such cases there may have been no symptoms before the acuter ones set in, or the symptoms may have been overlooked. It is not infrequent to find hospital patients suffering from advanced atrophic lesions, who aver that they were well, it may be, a week before their admission. Careful questioning may show that this statement is false. In dealing with hospital patients, one must remember that they are not usually observant, and often overlook slight ailments. The habits of many of the patients are such as to make them take certain symptoms as a matter of course. A man who gets drunk three times a week is not likely to consider headache, nausea, and vomiting as unusual events. A man whose life is spent in shovelling dirt and who never reads may easily overlook slight dimness of vision. A person who habitually drinks a large amount of beer will not be surprised at passing a great deal of urine.

Disturbance of the Nervous System.

Headache, more or less severe, occurs at some time in the course of most cases. The pain is usually general and not limited to one part of the head. It is sometimes severe, at others it scarcely amounts to more than a feeling of discomfort. Changes of disposition and irritability of temper are often observed. Some patients are much troubled with sleeplessness. A sense of muscular fatigue and aching in the limbs is felt by many. Neuralgia of various nerve trunks is sometimes a prominent symptom. It is well to look to the state of the kidneys in any case of neuralgia. Certain patients suffer severely from attacks of spasmodic colic which come on from time to time, and do not seem to depend upon the taking of indigestible food. Disturbances of vision—such as amblyopia (dimness of vision) and muscæ volitantes (floating spots), without visible retinal lesions—are not infrequent. Inflammation of the optic nerve also may cause dimness of sight. In advanced cases the symptoms of acute uræmia are often present.

Disturbance of the Circulatory and Respiratory Systems.

The pulse is in most cases one of high tension—long, slow, full, and strong. If patients at the end pass into a typhoid state the pulse may become small and feeble, even dicrotic. The tension falls also during the progress of any acute febrile disturbance in these patients. Dropsy is not often severe. It is frequently limited to trifling œdema about the ankles, and it may be absent; nevertheless, certain cases have general anasarca (dropsy). Toward the end it is not unusual to find some hydrothorax, hydropericardium, and ascites (dropsy). Œdema (dropsy) of the lungs is frequent a little while before death.

Dyspnœa (breathlessness) is very often a source of complaint. It occurs sometimes in attacks precisely like ordinary asthma (when it is called renal asthma), but more often it is the result of dropsy and anæmia (poor quality of blood), and is first noticed after exertion. Late in the disease it may be almost constantly present for days or even weeks, and may cause intense suffering.

Disturbance of the Alimentary Canal.

Loss of appetite, or a very variable appetite, is quite frequent. Some patients complain of thirst. Pain or discomfort in the epigastrium (upper part of the abdomen), pyrosis (heartburn), flatulence, and other symptoms of dyspepsia are present in a large number of cases. Nausea, with or without vomiting, is sometimes a troublesome symptom. In some cases the vomiting seems to be caused by undigested food, in others not. Diarrhœa occurs and is troublesome in some cases, but many are more or less constipated.

Anæmia, with marked loss of flesh and strength, is observed in very many cases. As has been said, the last mentioned symptoms—loss of flesh and strength —may be the earliest ones noticed by the patient.

As it is possible to have cases with this lesion which present no symptoms, so is it the more possible to have a large number of the symptoms described absent.

Course and Duration.

Patients rarely go on steadily from bad to worse. There may be months and years when, save for urinary changes, they seem in good health. After a while, however, they break down rapidly and die. The disease may last ten or fifteen years, or longer, dying, perhaps, of some intercurrent affection at the last. Its course is always slow.

Causes of Death.

Patients with this form of Bright's disease are very likely to die if seized with an acute disorder, like pneumonia or some fever. A considerable number of them die from some such intercurrent disease. A considerable number also die of apoplexy. Some die apparently from a gradual failure of strength, passing into a typhoid state before death. Others have the symptoms of acute uræmia and die comatose or in convulsions.

It is doubtful whether patients ever recover from this form of Bright's disease. It is usually stated that they do not. The disease is, however, so chronic in its course that the prognosis as to length of life is fair if the diagnosis be made early. The patients are liable, it is true, to die from some intercurrent disease, or from the results of some imprudence, but they may live many years in comparative comfort. As a patient with valvular heart disease may live a long time, with prudence and care in his mode of living, so may patients with atrophic kidneys. In individual cases the prognosis varies with the capability of the patient to carry out treatment, with the tendency of the disease to advance or not in a given case, and with the time at which the diagnosis is made.

Prognosis.

If a patient is able to have bodily and mental rest, to obtain proper food, and to reside in a warm climate, the prognosis is better than when he is unable to do these things. In some cases the disease seems to have a tendency to make more rapid progress than in others, in spite of all treatment. If the diagnosis be not made and treatment instituted until the lesion is already far advanced there is but little hope. A case in which marked uræmic symptoms have appeared rarely survives long, yet years may elapse between the first uræmic attack and death. Cases in which hæmorrhage into the retina has occurred are usually advanced and of the gravest prognosis. Cases in which there is pretty rapid loss of flesh and strength are also of grave prognosis. A pulse of very high tension is indicative of danger. The occurrence of an acute complication renders the patient's condition precarious. The prognosis in each case must be made from the symptoms of that case, and can not be generally indicated.

Treatment.

The indications are to build up the patient's strength, to relieve the kidneys of some of their work, and to combat dangerous or unpleasant symptoms as they arise. The food should be easily digested and nourishing. Although contrary to theory, many of these patients do well on a diet consisting almost entirely of albuminous food. In some cases a milk diet for several weeks is followed by good results. Tonics are useful in many cases. The state of the skin and bowels should be watched, but, unless dangerous symptoms call for it, too much sweating and purging should be avoided. Massage and daily baths, followed by friction with a coarse towel, are useful. Some patients enjoy, and are benefited by, occasional Turkish or Russian baths, but in others these are debilitating. Residence in a warm climate, life in the open air, moderate exercise, and complete freedom from worry are of great value. The bowels should be kept free by gentle aperients.

Nausea and vomiting and dyspeptic symptoms must be treated as these symptoms would be treated were there no kidney lesion. If the

urine becomes much diminished, diuretics may be of service. Many of the most unpleasant symptoms are relieved by drugs which reduce the high tension, such as chloral. Nitroglycerin and the nitrites are being extensively tried for this purpose at present and are worthy of further trial. Nitroglycerin is effective in some cases where the tension is very high, relieving the headache and other nervous symptoms in a remarkable way. Attacks of renal asthma are not often relieved by this drug, but usually are best treated by morphine.

DIABETES.

There are two entirely distinct diseases to which the name of diabetes has been given. Both are characterized by a great increase in the amount of urine passed. In one the urine is not only increased in quantity, but it also contains the form of sugar called glucose, a substance which is one of the products of digestion and assimilation (see *Physiology: The Vital Processes in Health*), which, however, does not normally appear in the urine, while in the other no glucose is found. The latter form of diabetes is comparatively rare, and is usually more annoying than dangerous, but it will not be described in this book. The reader is referred to articles upon *Diabetes insipidus*, or *Polyuria*, in the systematic treatises on medicine for information about it. The form here considered is what is known technically as *diabetes mellitus*, or *saccharine diabetes.*

Definition.

Diabetes mellitus is a disease characterized by an increased flow of urine which contains glucose, and by increased appetite, thirst, and loss of flesh and strength. The disease may prove fatal within a few months or may last for many years (fifteen to twenty, or more) if properly treated, and give the patient but little inconvenience.

Causes.

Diabetes occurs in both sexes and at all ages after early childhood. What change in the organs of the body cause it to appear is unknown. All that can be positively asserted is that it is *not* dependent upon disease of the *kidneys.* The prominence of the urinary symptoms makes it advisable to describe it among the true kidney diseases, and for this reason I have done so.

It seems to be caused by severe nervous shock, such as intense sudden grief or fright, in some cases. In others it follows prolonged mental strain, the result of anxiety and mental overwork. Gouty people sometimes develop it, and it is occasionally inherited from diabetic or gouty ancestors. It is asserted by some observers that the disease may be produced by excessive eating in persons of sedentary habits, but this is not very probable.

The first symptoms noticed differ in different cases. Perhaps that which is most commonly first noted by the patient is the increase in the

amount of water passed. He may be obliged to get up several times at night in order to empty the bladder. Excessive thirst first attracts the attention of some, while others observe that, in spite of an appetite which is unusually good, or perhaps even ravenous, they lose flesh and strength. Persons who have been accustomed to hard work may find themselves very easily fatigued, so that they are unable to do what they had looked upon previously as very light tasks, and they find that their memory is not so good as it had been, and their temper worse. Occasionally the nervous symptoms mentioned, together with intense mental depression, and perhaps also sleeplessness, languor, and more or less headache, first lead to an examination of the urine and the discovery in it of sugar. As the disease advances, in severe cases (*whose course is not modified by treatment*), the amount of urine passed may reach as much as eight or ten quarts in twenty-four hours, and, as a necessary result of this loss of water, the patient is compelled to drink a corresponding quantity. The urine is pale yellow in colour and sometimes is observed to make any article of clothing with which it comes in contact sticky or stiff to the touch. It is found to contain very variable quantities of glucose.*

Symptoms.

Cases are recorded in which more than two pounds of sugar were excreted daily; but this is an enormous quantity, and even very severe cases rarely exceed eight to ten ounces. The quantity of food taken and digested without apparent trouble by a diabetic is frequently astounding; it is not unusual for him to grow thin on a diet which would literally sustain five or six strong men in perfect health.

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* The presence of this substance makes the specific gravity of the urine higher than normal: it may be found to be 1050 or 1060. (The specific gravity of water being 1000, the specific gravity—*i. e.*, comparative weight of an equal bulk—of normal urine is from 1015 to 1025, more or less.) The sugar ferments when a little yeast is put into the urine, and becomes converted into carbonic-acid gas which escapes in the form of bubbles, and alcohol. The simplest way of estimating the amount of sugar present is to collect all the urine passed in twenty-four hours in *one* clean vessel of sufficient size. The entire quantity is then measured, and from it a few ounces are taken and the specific gravity is ascertained by means of an urinometer (Fig. 1). A small piece of compressed yeast is then added, and the specimen set aside in a warm place for twenty-four hours, or until fermentation is complete. The decomposition of the sugar causes the specific gravity to fall, and the difference of that noted after fermentation and that previously obtained measures with fair accuracy the proportional amount of glucose. Each degree of loss in specific gravity indicates the presence of one grain of sugar to the ounce of urine passed. Thus let us suppose that a patient has passed 100 ounces of urine having a gravity of 1045, and that, after fermentation, the gravity is found to be 1010, the difference, being 35°, indicates that each ounce of urine contained 35 grains of sugar, and that the total amount of 100 ounces contained $100 \times 35 = 3{,}500$ grains, or $\frac{1}{2}$ lb. avoirdupois.

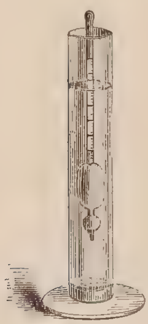

FIG. 1.—AN URINOMETER.

Unless checked by treatment, the disease grows progressively worse; emaciation becomes extreme; the weakness confines the patient to bed; the skin becomes dry and scaly; there is a peculiar odour of a sweetish, sickening character to the breath; finally death ensues either from coma, which is called acetonæmia, or suddenly and without warning, or more frequently from the effects of some complication.

Severe cases may terminate fatally within a year from the time when the first symptoms were observed; the affection is, however, essentially chronic in its course, and life is often prolonged for a number of years, especially in cases which are properly and systematically treated. A considerable number of these live ten years or more, provided they are careful in their diet and in avoiding fatigue and exposure. The symptoms, save the sugar in the urine, may practically be absent for months at a time, and then only reappear in a mild form. Nevertheless, the diabetic lives with a sword suspended over him continually.

Complications.

Consumption kills many and is very common. Acute pneumonia is a quite frequent cause of death. Acute inflammations of the skin, in the form of boils and carbuncles, are frequently met with, and are dangerous because the diabetic is very liable to fatal blood poisoning from them.

Treatment.

The treatment consists in restricting the diet, so far as possible, to food which does not yield sugar in the process of assimilation. In many cases its results are very favourable; but there is much difficulty in forcing the patient to avoid the harmful articles of food. It is impossible for man to live entirely without starch or sugar for a very long time; these are the substances from which glucose is made in the body. The more completely and continuously a diabetic avoids them, the better are his chances of longer life and very fairly good health. For details of the diet to be pursued, the special works on the subject must be consulted.

THE EXAMINATION OF URINE.

Anything approaching a complete examination of urine can only be made by one who has acquired the requisite skill by practice to enable him to perform the necessary manipulations and observe accurately the chemical reactions and microscopic findings. A brief description of the methods employed may be of interest to readers of this book.

In examining a specimen of urine, the observer first notes its general characters as to colour, odour, degree of transparency, and the presence or absence of any precipitate visible to the naked eye.

The colour of the urine varies greatly in health, and can not by itself be taken to indicate disease of the kidneys. In a great number of abnormal conditions other than kidney disease urine deposits larger or smaller

quantities of precipitates on standing. These may be composed of white phosphates, or pink urates, or bright-red crystals of uric acid (so-called "brick dust"), or of pus, mucus, blood disks, casts of the kidney tubes, or epithelial cells derived from some part of the urinary tract. To determine the nature of a precipitate the microscope is used as well as certain chemical reagents.

After noting the gross physical characters of the specimen its reaction is taken by dipping into it small pieces of paper coloured with litmus. This dye has the peculiarity of changing its colour in fluids of different reactions. The test papers are coloured, some blue and some red. If the reaction be acid, the blue paper becomes red; if alkaline, the red paper becomes blue; while in neutral fluids no change is observed in the colours.

The specific gravity is next ascertained by means of an urinometer (see note on page 722). After this has been done the specimen is submitted to tests having for their object the demonstration of the presence or absence of certain substances which are not present in normal urine. The more important of these are albumin and glucose.

Two tests are most commonly employed for detecting albumin: (1) the application of heat, and (2) the careful addition of a small amount of strong nitric acid. In making these tests the following precautions are absolutely necessary: When heat is used albumin is coagulated and forms a white cloud, *provided the urine is acid in reaction.* If it is alkaline, not only may albumin fail to coagulate, but also a white cloud of phosphates may be formed; therefore if the reaction be not acid, it must be made so by the addition of a drop of dilute acetic acid before boiling. Nitric acid may give a precipitate of urates, but this dissolves readily upon gently heating the specimen; therefore a precipitate formed by nitric acid should always be heated to boiling before it is regarded as albumin.

Glucose is detected by means of a solution of a salt of copper which yields a dense yellow precipitate of oxide of copper when boiled with a fluid containing small amounts of that substance. This test is delicate, but it requires much care in its application; and the reader is referred to the text-books upon urine analysis for the details. Sometimes a solution of a salt of bismuth, which yields a black precipitate when heated with glucose, is used instead of the copper solution.

In some cases special tests are necessary to determine the presence or absence of bile or of blood-colouring matter. These will be found described in the text-books.

The microscope enables the observer to look for blood disks and white blood cells, pus, epithelium, casts, mucus, etc., and to recognise the physical appearance of various chemical precipitates. It also makes possible the demonstration of various bacteria occasionally found in urine.

X.

DISEASES OF WOMEN AND MIDWIFERY.

By SAMUEL WALDRON LAMBERT, M. D.

INTRODUCTION.

Definitions.

Obstetrics, or midwifery, is that portion of medical science and art which deals with pregnancy, with parturition, and with the puerperal state in all their physiological and pathological relations. Gynæcology is, in its best and broadest sense, a more comprehensive term, and includes within its definition the science of obstetrics and, in addition, all else which is peculiar to woman from the various points of view of hygiene, physiology, and medicine.

Functions of Womankind.

The greater number of the following pages are devoted to a consideration of the normal manifestations of the various functions of womankind. Facts concerning the abnormal action of these processes are discussed only as far as they would be likely to attract the attention of the non-professional observer. These processes, peculiar to the female sex, are all connected with the one great function of childbearing. At least thirty years of the natural life of woman are given up to the monthly recurring preparation for this function, or to the actual performance of it.

Three Critical Seasons.

Three critical seasons occur in the life of every woman as she lives through this period of generative activity. The first marks its onset, and is known as the age of puberty. The second critical time is the most important of the three; it begins with pregnancy, includes parturition, and only ends with the cessation of lactation. The final, least significant, crisis marks the end of the childbearing period, and is called the menopause, or change of life.

All considerations of anatomy are omitted from this article, which treats entirely of the physiological processes and of the principal manifestations of disease. The reader is referred to Fig. 48 in the article on *Physiology: The Vital Processes in Health*, for a schematic drawing of the anatomical relations of the special organs of the female.

CHAPTER I.

MENSTRUATION.

Ovulation.

The female germinal cell, the ovum or "egg," is differentiated for its special destiny from the remaining cells of the body of the human female even while this individual is sojourning in the womb of its mother. Thus the protoplasm of the third generation lives in the body of the individual of the second generation before the birth of the latter. These ova are developed in special organs called ovaries. They are ripened at regular intervals, and are discharged from the ovary when mature. They reach the uterine cavity and either die and are discharged from the body of the woman, or they become fecundated by combining with the generative cell of the male, and undergo further growth. This periodic development and discharge of the ripe ovules is known as the process of ovulation. The human egg is a microscopic object, and if the process described constituted the whole series of phenomena which took place at the time of the periodic discharge of such small cells from the ovary, there would never be any tangible manifestation to mark the event. Such may be sometimes the case, and ovulation without external signs may occur.

Uterine Menstruation.

It is usual, however, that the lining membrane of the uterus gives very decided evidence of its participation in the event. The uterus of every healthy woman loses part of its lining membrane at certain regular intervals. This interval is twenty-eight days in a majority of cases. This process of degeneration lasts about five days, and causes a distinct congestion of the uterus and the neighbouring organs, and a bleeding from the uterus appears from the vagina. This process is known as menstruation. Although ovulation and menstruation are usually concurrent in time, either may occur independently of the other.

This periodic discharge is a necessary preparation for pregnancy. The fecundated ovule lodges in the renewed mucous membrane of the uterus, and takes nourishment from it until more intimate relations of interchange can be established between the circulation of the mother and that of her unborn child. If the ovum be not fecundated, the newly prepared membrane of the uterus degenerates at the end of its allotted time—twenty-eight days after the degeneration of its predecessor.

Menstruation is continued with great regularity after it is once established. Its onset marks the beginning and its permanent cessation marks the end of the possible childbearing period of every individual.

The transition period, during which a child ceases to be a child, is

known as the time of puberty. This change is no sudden one, but the characteristics of childhood gradually merge into those of adult womanhood or manhood. Until this metamorphosis begins, the physical development is practically the same in both sexes. This process of change begins earlier in the female sex than it does in the male, and is recognised before the law as completed in girls at the age of thirteen, in boys at fourteen. Perfection of development is not attained, however, by either sex until several more years have elapsed.

Puberty.

In girls there are many signs of approaching maturity which are well advanced before menstruation, the most characteristic of them all, appears. The whole contour of the body changes. The hips broaden by an actual growth of the bony pelvis, causing the shoulders to appear relatively narrow. The breasts begin to enlarge, and the nipples to become more prominent. The whole body becomes stouter (especially the thighs and buttocks), in consequence of an increase in the subcutaneous fat. In addition to these more evident changes, there are others which are less prominent. There is a marked growth and development of the special organs of generation. The uterus and vagina enlarge, and the external parts share in the same growth.

First Menstruation.

The first menstruation may occur without any disagreeable symptoms at all. At other times it will be preceded by a varying number of attacks of what seems to be an ineffectual effort on the part of Nature to begin this function. These attacks may be accompanied by a more or less colicky pain in the lower part of the abdomen, by distention of the bowels with gas, by aching pains in the back and thighs, and by a certain amount of mucus discharge from the vagina. At other times these attacks are of a nervous character and present symptoms of an indefinite nature. The true significance of the attacks may not be suspected until it is noticed that they disappear when normal menstruation is regularly instituted.

Care of Young Girls at Puberty.

Every child should receive at this period of life such care and advice that she may be saved from the two extremes of excessive solicitude on the one hand and of neglectful unconcern on the other. Such careful oversight is as necessary for those girls who pass through this transition period without special symptoms as for those others who suffer from the various phases of physical and nervous disorders already referred to. No child is old enough to menstruate who is too young to be told why she does so and what it means. To instruct such a child in a right manner is perhaps the most difficult task which is demanded of every mother. The child must be made to feel that the event is not extraordinary, but that it is a quite natural and normal function of the body. She must be instructed con-

cerning the periodicity, the character, the amount, the duration, and the significance of the menstrual flow. Above all, she must be forewarned of the coming of the first menstruation. This much she must know, but there are subjects in regard to which she should not be instructed. It is unwise for any child to get a preconceived idea that menstruation is a painful disease and much to be dreaded. The widespread mode of speech by which menstruation is designated a state of "being unwell" is at best an unfortunate one. The child about to menstruate should not be told that the expected event may be painful, or that there may be any disagreeable accompaniment whatever. She should never be nagged at with questions as to her feelings, as to her head, and especially not as to her nerves. Such anxious questioning will only increase any natural tendency to nervousness or to hysterical symptoms that may be present, and will bring about the condition it is intended to overcome. If the particular individual is to be a sufferer from any of the disorders of menstruation, the symptoms will appear of themselves only too soon, and they can be treated best as they arise. To sum up, it may be stated that *girls at the age of approaching puberty should be instructed in the outlines of the physiology of their sexual functions, and should be left to learn by experience, if need be, all pathological facts on the same subject.*

It is important that such a girl keep quiet for twenty-four or thirty-six hours every time menstruation begins, at least during the first two years after its onset. It is really essential that the habit of regularity in this function be established as early as possible, and nothing assists so much to this end as careful rest and quiet during the first days of each monthly period. After the periods have begun to recur with regularity and are firmly established in their monthly habit, it is possible and right to allow greater freedom to those girls who do not suffer pain; but even they should be more quiet than at other times. Women who must work may continue to do so, but should curtail unnecessary physical exercise, and not lose sleep and rest for mere recreation.

Normal Menstruation.

The fluid which is discharged from the genital tract in normal menstruation is blood mixed with the mucous secretion of the vagina. At the outset it is merely stained pink, but rapidly becomes dark blood-red, and finally, as it becomes less in amount, either grows paler or becomes dark and almost black. This discharge has a peculiar odour, due to the presence of certain acids, the products of a fermentative action. Menstrual blood remains fluid and viscid, and does not clot as ordinary blood does, except it be retained in the uterus for some length of time. The coagulation is hindered normally by the admixture of the acid mucus of the vagina. The duration of the flow varies in different women from one to eight days, and the amount lost depends also in great measure upon the individual; an

average would be three or four ounces for the whole period. The flow begins, in most cases, rather suddenly, increases for one day, and after remaining stationary at its height for two days it finally ceases gradually. During these days there may be a slight swelling and itching of the external organs. The breasts also may become tender, hard, and swollen, and may secrete a drop or two of fluid. The nipple may become distinctly darker in colour. Certain women never have any feelings of discomfort whatever during their menstrual periods, but the majority of individuals suffer during the first days of each epoch from a feeling of weight and heat in the lower abdomen and of general aching in the back and thighs. There is also a varying degree of nervous irritability and of mental depression. The body temperature will be found elevated a fraction of a degree during the menstrual flow, and the pulse is often quickened. A number of nervous symptoms may present themselves, such as headache, dizziness, chilly feelings, neuralgic pains, palpitation, and frequent desire to empty the bladder and rectum. Abdominal symptoms of colic, of gaseous distention, of intestinal gurgling, of vomiting, and of diarrhœa may occur. The presence of any combination of these various symptoms is indicative of a general reflex irritability, and not of any pathological process with organic lesion. Such cases of slight degree must still be classified as normal, although it is difficult to draw the line where the diseased process begins.

These discomforts of menstruation are most marked in women who have not borne children, although exceptionally they continue through the whole period of menstrual activity. The manifestations of normal menstruation may be altered to such a degree that the existing condition may be considered as morbid or diseased.

Hysteria.

The attendant symptoms referable to the nervous system may be exaggerated, and each recurring period be associated with an attack of true hysteria. Hysteria is a peculiar functional disease of the higher brain centres, resulting in a lack of control of the mind and body, and accompanied by any of the possible derangements of the physiological functions of the body. Hysteria is not essentially connected with the generative organs, but is the result of some irritation either from within or from without the body acting on a weakened nervous system. The hysteria of menstruation differs in no respect from that induced by other kinds of irritation. Its manifestations are so numerous that it is impossible to give any adequate idea of them within the scope of this article. It should be remembered, however, that hysteria is a real disease, and that the sufferer is irresponsible and is not feigning, however much certain symptoms may resemble an outbreak of bad temper, or seem to be the results of a morbid desire for sympathy or of selfishness.

Another disorder of menstruation is an increase in the pain, and this is not uncommon in women who have been childless. The "normal" pain of menstruation is usually of a neuralgic nature, and precedes the establishment of the flow or accompanies its onset. The pain is due, in other cases, to an obstruction to the escape of the menstrual discharge from the uterus. A cramplike, painful contraction of the uterus is induced by this anatomical condition. The obstruction may be due to a congenital or acquired narrowing of the canal in the neck of the womb, or to a clotted and solid condition in the blood which has to pass through an otherwise sufficiently patulous opening. This pain of obstruction may be very severe and continuous, but usually recurs with exacerbations, and is at times of the nature of labour pains; it is in reality due to the same cause.

Pain.

The menstrual discharge may change its character as to amount, as to its physical qualities, or as to its regular periodicity, and such change may be sufficiently marked to constitute a diseased condition. The menstrual blood may become *clotted* before it leaves the uterus, either because it is retained in that organ too long or because there is too much of it. This condition in itself is, as just mentioned, of most consequence as an exciter of pain.

The mucous membrane of the uterus may be shed at these times in large pieces instead of degenerating into microscopic *débris*. These more or less perfect casts of the uterus are discharged with symptoms of fever, abdominal pain, hysterical attacks, and, while the membrane itself is being discharged, of severe expulsive pains. The accompanying flow of blood is usually slight, and the periods in these cases recur irregularly.

Membranous Dysmenorrhœa.

At times there will be a discharge of dark-brownish fluid instead of the normal flow of blood. This change may be of no significance whatever, or it may be associated with some of the acute infectious fevers or with chronic wasting diseases. Variations in the periodicity and in the amount of discharge are related closely to each other and in a direct ratio: the more frequent the flow, the greater the amount. Those causes which act to diminish the amount of discharge act also to make the same a less frequent occurrence.

Change of Colour.

Diminution or cessation of menstruation may be due to any general disease which leads to an impoverished condition of the blood. Perhaps the best example of such a disease is tuberculosis in any one of its manifold forms. The essential anæmias lead to the same result; the most common form of anæmia is that which occurs in young women, and which leads particularly to omissions and diminution of the menstrual flow. Exposure to wet and cold and great mental excitement of any kind may cause a single omission

Absence of or Scanty Menstruation.

of this function, but the diseases just mentioned cause prolonged cessation or a much-diminished flow at long intervals. There is a popular belief that tardy menstruation is a very serious condition, but as a rule it is easily treated by general measures directed to the cause, and demands prompt attention, but is not a sufficient ground for the worry so often given to it. The failure of this function to appear at the time of puberty may be due to congenital malformation of the genital organs. Pregnancy and lactation act as a physiological check to the function of menstruation, which is not re-established until after lactation has been continued for at least six months.

Excessive Menstruation.

Excessive increase in the amount of the menstrual flow is usually associated with too long duration of that flow, and often also with its too frequent recurrence. These allied conditions may be due to local causes, or to diseases of other organs which lead to pelvic congestion. Chronic disease of the heart, liver, kidney, and intestinal tract may lead to such a series of symptoms.

Vicarious Menstruation.

An unusual irregularity of menstruation is presented in a few women who have a periodic bleeding from some part of the body other than the uterus. Usually there is a simultaneous slight "show" from the vagina and a larger hæmorrhage from the vicarious site. The nose and air passages are the most frequent part of the body to be thus affected.

Treatment of Menstrual Disorders.

All of the serious complications of menstruation demand medical care, and it is beyond our present province to give minute details of such measures. None of these disorders should be allowed to continue indefinitely without some attempt being made to correct them. Temporary delay in the onset, or momentary excess, or diminution in the amount of the flow, or a single attack of nervous symptoms, usually absent, can be the result of temporary causes, and need not demand skilled advice.

Perhaps the cases which will permit the least delay are those of the non-appearance of the flow in young girls in whom attacks of menstrual pain and distress recur at more or less regular intervals and with steadily increasing severity, and in whom there are no external signs of menstruation. This usually means that there is some congenital deformity resulting in a retention of the discharges. It is fortunately a rare condition, but it is one needing prompt surgical treatment.

Simple Rules for all Women.

It is wise for almost all women to remain quiet every month during the hours when the discharge begins. It is not necessary for all to go to bed, but a certain degree of rest in the house, and possibly the application of continued heat to the abdomen, will shorten the period of relaxation, and

render them more able to go about during the latter part of the menstrual time. It is unnecessary for most women to restrict themselves to a fluid diet at these times. Fried foods and highly spiced foods are distinctly difficult of digestion at any time, and should be avoided now. The use of wine or other forms of alcohol is in general to be discouraged.

City-bred girls are of a more nervous temperament than country-bred girls, and are more apt to present the severe types of menstrual disturbance. One reason for this is the difference in their mode of life. Exercise—and out-of-door exercise is the best—is an essential element in the life of most women, and it is one that is neglected. The muscles of the shoulders, arms, and upper part of the trunk seldom receive any attention in this regard, whereas the amount of walking and stair-climbing of the regular routine of life exercises the legs sufficiently without special care being necessary. Nowadays there are gymnasia and various classes for the cultivation of grace and exercise enough, but it takes time and trouble to follow them systematically. Every girl who makes her own bed and who sweeps and dusts her own room is a healthier woman because of this daily exercise than her sister who has no such habit. A good and efficient substitute for sweeping, etc., will be furnished by the routine use of a pair of wooden dumb-bells for five minutes each morning and evening. Anything which improves the general health will lessen the pains and discomforts of menstruation; regular exercise is such a thing. A further necessary requirement for continued good health and for normal menstrual function is a regular daily movement of the bowels. This can be secured best by establishing a habit of attending to this need at a definite hour each day. Once established, such a habit becomes a second nature.

During the monthly periods all energetic exercises should cease; this applies especially to horseback riding, long drives, tennis, bicycling, and dancing. The same rule of abstinence applies to prolonged standing, as in sight-seeing of all kinds, the inspection of picture galleries, the being fitted at a dressmaker's, etc. Exposure to cold and wet, even of the feet alone, is to be avoided at these periods, when the whole system is relaxed, and the slight catarrhal inflammations of the nose, bronchial tubes, and throat are more likely to follow than they are at other times. A possible result of such imprudence as already mentioned is the sudden cessation of the monthly flow. If such a stoppage occurs, it may return after a series of hot baths, hot mustard foot-baths, rest in bed, and hot applications to the abdomen. If it does not return within a few hours it probably will not do so until the next period is due. Even such a result is not necessarily a matter for alarm or worry.

The regular treatment of those women who suffer each month from the lesser degrees of menstrual disorder is to be carried out on the same

lines as already detailed—rest and quiet in bed, continuous dry heat to the abdomen, plain, nourishing food, and at the time of onset hot baths to the whole body or to the feet alone. Further indications for treatment may arise, but they will depend on the individual case and should be referred to the family physician.

Menopause.

The childbearing period ends in the latter half of the fifth decade of life—usually between the forty-fifth and fiftieth year. In general, the earlier it begins the longer it lasts. Menstruation usually ceases gradually, the periods become shorter and the flow less, then the intervals lengthen, and finally it stops, or it may stop abruptly. This period of the climacteric, or change of life, may be characterized by no other symptoms. In certain women, however, these last few periods will be attended by an excessive loss of blood. This hæmorrhage may be so large that the individual becomes anæmic and may remain so for some time in spite of treatment. In other cases the women grow fat; they sweat a good deal; they may have intestinal or gastric indigestion, with water brash and formation of gaseous products, headaches, dizziness, and peculiar feelings of heat and cold in the upper part of the body—the so-called "hot flashes." These symptoms are usually of nervous origin and may require medical treatment. There is a widespread and popular idea that this time of life is particularly dangerous to women, whereas with care the distressing symptoms will regularly disappear.

The menopause occurs at an age when nearly every woman becomes careless about daily exercise and about an active mode of life. If she continues to eat she becomes fat and her liver becomes torpid. Many of the symptoms of the climacteric are really due to so-called functional disturbance of the liver. In the worst cases the arteries degenerate and gout and chronic rheumatism develop.

Such cases must be treated by meeting the indications of special diseases, and, in addition, by general measures directed to re-establish a healthy manner of living.

A moderate, easily digestible diet, massage, and necessary exercise will assist greatly. Above all, an overtaxing of the strength by excessive social duties and mental work must be avoided.

CHAPTER II.

PREGNANCY.

WHENEVER an ovum becomes impregnated it begins to grow and to develop. In consequence of this development the special organs of the female become modified so as to supply the necessary nourishment to the growing ovum. The process thus begun can be divided into certain periods: First, that during which the ovum remains within the body of its mother and is nourished directly from her blood; second, that during which the fully developed offspring is separated from its mother and begins to lead an individual existence; and third, that period during which the child, though separated from its mother, is nevertheless dependent on her for food in the form of milk. The first period is known as pregnancy, or gestation, the second as parturition, or labour, and the third as the period of lactation.

Development of an Ovum.

The changes which begin to develop in the body of a woman as soon as pregnancy has commenced are at first slight and can not be detected. Certain subjective feelings on the part of the woman appear more or less early and will lead to a presumption in favour of the presence of pregnancy. No one of these subjective signs and no combination of them without the addition of some of the objective signs to be described below can raise the question of even a probability of the existence of pregnancy. All of these subjective symptoms may be caused by other conditions.

Signs of Pregnancy.

The symptoms of this class may be referred to the digestive apparatus and to the nervous system. The most common deviation from normal digestion is a diminution of functions characterized by a loss of appetite, and resulting in consequence in a certain amount of paleness and of loss of flesh. Added to this there may be certain perverted desires for unusual food, also nausea and vomiting. The less common change in digestion during the early months is an increased appetite, improved circulation, heightened colour in the lips and cheeks, and gain in flesh. As a rule, the bowels become constipated; rarely there is diarrhœa. The absence of any or all of these "symptoms" is no contra-indication of the presence of pregnancy.

Subjective Signs.

The *nausea* and *vomiting* of pregnancy are fairly characteristic. They are most marked in the morning and are usually confined to that time of day. These are symptoms of the early weeks of pregnancy and disappear during the third or fourth month. Vomiting may become so constant and severe that it will demand active treatment. The slighter cases will be

controlled by careful dieting, by avoiding richly seasoned, fatty, and fried foods, and hot breads. It is wise also to eat something before rising, and to remain in bed for two hours later than the usual rising hour. This early meal should be a very simple one—cocoa, coffee, or milk, and bread which is not freshly baked should suffice. The subsequent meals of the day may usually be enjoyed without many restrictions. A multitude of drugs have been suggested, and certain of them are of benefit, but they should be selected to suit each individual only under professional advice.

The functional disturbances of the nervous system are due to an increased irritability of the nervous centres. Feelings of heat referred to the skin, of indefinite weakness, and of irresistible sleepiness, are not uncommon. Fanciful likes and dislikes both for people and for inanimate objects are commonly known as the "longings" of pregnancy. The character of a pregnant woman is often essentially changed. Sadness rather than joy is apt to be the keynote of the thoughts of a prospective mother.

Objective Signs of Pregnancy: Cessation of Menstruation.

The first objective sign that will attract the notice of the pregnant woman will be the cessation of her monthly periods. This symptom, following the recent development of any of the subjective signs just described, and occurring in a married woman who has been previously of a regular menstrual habit, raises at once the probability of the existence of pregnancy. In the case of women who have always been irregular in this function a single omission, even with all the subjective signs, is of no diagnostic value at all. It is also true that a pregnancy may exist and a monthly discharge be repeated for several regular periods. This is a very exceptional occurrence, however. The cessation of menstruation does not occur as a sign of pregnancy when pregnancy begins while the woman is nursing a child, because as a rule the menstrual function is not re-established until after lactation is ended. During the second month of gestation the evidences of its existence begin to multiply, and by the time the second menstrual period is skipped it would be often possible for a skilled examiner to ascertain the probable presence or absence of pregnancy. These early changes in the generative organs would not be apparent to the lay observer, including the pregnant woman herself.

Changes in the Breasts.

The symptom next in order to attract the attention of the pregnant woman is a series of changes in the breasts. The breasts begin to be prepared for their functional activity as early as the second month of pregnancy, and this development is progressive up to the time of labour. The breasts increase in size and become more or less tender to pressure. The swelling may stretch the skin to such an extent that certain markings occur, called

striæ, similar to those on the abdomen, described below. In addition, the subcutaneous veins enlarge, and a few drops of a yellowish liquid, a partly formed milk, may be expressed from the nipple. The nipple becomes larger, more prominent, more sensitive, and darker in colour. The nipple is one of the first places to show the dark pigmentation of the skin, here called the areola, which is characteristic of the pregnant condition. In addition to these signs certain small swellings, four to twelve in number, appear arranged around and near the nipple. Finally a coloration of the skin is developed in a circle of varying extent about the nipple itself; the pigment is arranged in a series of little circles about an eighth of an inch in diameter around the openings of the sweat glands. The outer edge of this secondary areola fades off gradually into the normal skin. These breast signs vary much in different women, are more marked in a first pregnancy than in subsequent ones, and the pigmentation is more marked in brunettes than in blonde women.

Changes in the Abdomen.

The digestive disturbances of early pregnancy will cause a temporary distention of the abdomen by gaseous dyspepsia, but a permanent increase in the size of the abdomen does not occur until about the third month of pregnancy. From this period on to the end of gestation the size of the abdomen increases gradually in consequence of the growth of the uterus and its contents. The growing uterus may be felt as a hard, round swelling in the lower part of the abdomen, which follows a certain definite rate of progressive growth, and is thus one of the most important signs of pregnancy. Enlargements of the uterus from other causes will never follow the same rate of increase. The landmarks by which this regular growth may be controlled are indicated below in the table.

The striæ on the abdomen due to the stretching of the skin appear as slightly depressed lines of a reddish-brown colour. They may be limited to the anterior abdominal wall below the navel, or they may be generally distributed and very numerous. In consequence of their mode of origin, they are most marked toward the close of pregnancy. These marks are permanent, and remain after the birth of the child as white, scar-like lines. New striæ with the characteristic colour may develop during any pregnancy subsequent to the first. The navel or umbilicus undergoes certain changes in consequence of the abdominal distention. The usual depression is gradually effaced, becomes level with the surrounding skin at the seventh month of pregnancy, and finally projects to a greater or less extent above the surrounding surface of the abdomen. Finally, the skin of the abdomen shares in the deposit of pigment, which has been described above as occurring over the mammary glands. This pigmentation is most marked along the central vertical line and over the upper and inner aspect of the thighs.

No one of the symptoms already described is in itself of any positive value, although the simultaneous existence of many of these signs adds to the importance of each. The only certain signs of pregnancy are referable to the fœtus itself. And of these only two are absolutely free from the possibility of error or mistake at the hands even of a skilled observer.

Certain Signs of Pregnancy.

The recognition by the sense of touch of a portion of the body of an unborn child and the hearing of the fœtal heart-beat can occur only during the examination of a pregnant woman. The heart-beat of the fœtus is heard usually just below and to the left of the umbilicus in the central portion of the abdomen; it resembles the regular tick, tick of a watch in its rhythm and averages about 140 beats to the minute.

The body and limbs of a child still in the uterus of its mother can be felt through the abdominal wall as soon as the uterus and its contents have grown to a sufficient size; this is usually the case during the sixth month of pregnancy. The position of the child can be accurately mapped out by an educated touch, but probably an untrained hand would discover little more than the movements of the contained mass. These movements of the fœtus are perceptible to the mother some time before they can be felt upon the abdomen. This phenomenon is known as "quickening," and occurs during the latter part of the fifth month.

The growth of the uterus encroaches eventually upon the regions usually occupied by other organs. Certain symptoms referable to these organs result from this mechanical interference with their functions. The lower bowel and the bladder are pressed upon, and there result an irritability of the latter and frequent desire to pass water; also a mechanical obstruction to the filling of the rectum, and a distinctly greater degree of constipation than characterized the earlier months of pregnancy. These bowel and bladder symptoms are greatest during the last weeks of pregnancy.

Mechanical Interference with Various Organs.

The enlargement of the abdomen restricts secondarily the capacity of the chest, and in consequence the breathing becomes more or less difficult as the pregnancy draws to a close. Finally, the circulation of the blood is interfered with. First, direct pressure on the veins returning from the lower extremities causes swelling of the feet and legs and dilatation of the veins, especially those of the pelvis. When the veins of the rectum are involved they swell up and form piles. And, secondly, an increase in the amount of tissue to be supplied with blood causes a compensatory enlargement of the heart, which is of good import and gives no symptoms.

It may not be possible to determine the period of pregnancy at which any particular woman is. It is important to do so as accurately as may be because of its bearing on the date of probable confinement. Most

rules for determining this future but important day are based on the estimate that the average duration of pregnancy is between two hundred and seventy and two hundred and eighty days. The two fixed dates from which reckoning may be made are the last menstrual period and the date of quickening; of these, the first is the more trustworthy. The best rule is the following: Add seven days to the date of the first day of the last menstruation and count back three months. The date thus fixed is the probable date of delivery. Reckoning from the date of quickening is a very uncertain method, and only of value when taken into account with the other facts which can be obtained by examination of the patient. The following table presents the symptoms which have just been detailed arranged in the order of their development. It may be of use in determining the period of pregnancy:

Period of Pregnancy.

Month of gestation.	Height of uterus.	Maternal changes.	Signs of fœtal development.
First and second.	At end of second month, at level of pubic bone.	Suppression of menses, swelling of breasts, nausea, vomiting, sleepiness.	None.
Third and fourth.	At end of third month, easily palpable in lower abdomen; at end of fourth, half way between pubes and navel.	More marked swelling of breasts, slight pigmentation and enlargement of nipple.	None.
Fifth and sixth.	At end of fifth month, an inch below navel; at end of sixth, an inch above navel.	Disappearance of functional disturbances, darker areola of breast, secondary areola of breast, enlarged tubercles of breast, pigmentation of abdomen, levelling of navel.	Quickening before end of fifth month; fœtal heart heard during sixth month.
Seventh and eighth.	At end of seventh month, three fingerbreadths above navel; at end of eighth, five fingers above navel inclined to right.	Striæ appear on abdomen and on breasts, navel level, secretion of colostrum in breast, swelling of feet and legs in certain cases.	Above continue and increase, especially fœtal movement.
First two weeks of ninth.	Under false ribs of right side and to end of sternum.	Embarrassment of respiration; vomiting may reappear; all others increase.	Same as last.
Second two weeks of ninth.	Lower than last.	More vomiting, piles, swelling of veins of legs, irritation of bladder, trouble in walking, pain in back.	Same as last.

The various receptive and eliminative apparatuses of a woman must accomplish during pregnancy double physiological work: thus the digestive system must continue to prepare enough nutriment for the future mother, and in addition must furnish the proper sustenance for her

offspring; the lungs must absorb more oxygen and give off more carbonic acid than before; the skin and kidneys must remove the waste products resulting both from the energy of the mother and also from that of the child; and the blood must carry the increased supplies needed for growth, and also the increased amount of refuse materials resulting from that growth. It is essential, therefore, that the pregnant woman lead a healthful, quiet life, and that she be more careful than ordinary about matters of general hygiene. This general rule is of most particular application during the latter months of pregnancy when the strain on the woman's organs is at its height.

Strain on the Organs.

Such a woman should live in sunny, well-ventilated apartments, should not frequent crowded assemblies, or remain for any length of time in air overloaded with carbonic-acid gas. If she is a working woman she should avoid work which exposes her to unhygienic surroundings. In general, she should live in sanitary surroundings, and if she do not, the penalties in loss of health will increase after she becomes pregnant.

Dwelling.

The clothing should be of such a nature that it will not press upon and displace the growing uterus or the enlarging breasts. *The enlargement of the abdomen can not be prevented, and a considerable amount of harm can be done by futile attempts to disguise the facts of the case as long as may be.* Whenever the waistbands of the skirts or the bust measure of any garment become tight and cause distress, they must be loosened at once, and this process of gradual enlargement must be continued to the end of the nine months. The question of corsets is a much-disputed one, but is simply solved. The same rule as already laid down for clothing in general applies also to the corset. If any corset is uncomfortable or painful at any time it is doing harm at that moment. If it sits easily and does not press upon the breasts or uterus to check their growth, such a corset is not more harmful than a similar pair in the non-pregnant condition. The final question as to whether any particular garment is exerting harmful or painful pressure at any time can not always be left for decision to the patient herself.

Clothing.

The clothing should protect against the weather, and be warm in winter and cool in summer. As pregnancy advances, walking becomes more and more a burden, so that shoes should be selected with low, broad heels, which will lighten the task and will check a tendency to slip and stumble. The stockings should be held up in place by strap garters attached to the corsets above or to a shoulder brace. Elastic clasp garters increase the obstruction to the circulation in the veins of the legs, and undoubtedly increase the tendency to varicose veins during the last months of pregnancy.

Diet.

The food of the pregnant woman should be nutritious and, as a rule, not excessive. In general, the particular choice may be left to the individual, and anything may be eaten which can be digested without discomfort. Whatever may have been the habit of the non-pregnant woman as regards the use of wine, it is an undoubted fact that alcohol in any form is, during the latter months of pregnancy, an irritant to the kidneys, and distinctly contra-indicated, whereas alcohol in the beginning of pregnancy is often an aid to the treatment of the irritable condition of the stomach so common at that time.

Exercise.

Exercise should be taken at regular daily intervals and out of doors. The amount will vary according to the individual. The kind of exercise will depend on the power of endurance of the woman in question. Walking is undoubtedly the best and most generally available form of out-of-door activity. Driving can be indulged in, though long drives are very fatiguing. Bicycling, swimming, riding, dancing, tennis, and similar violent exercises are not to be indulged in, not always because dangerous in themselves for healthy pregnant women, but because such exercises carry with them a liability to severe jarring and jolting shocks from the many accidents which may occur. Similar shocks and a consequent interruption of pregnancy can result from work of a too violent kind; work on the sewing machine is of this class and is to be avoided.

Journeys.

Travelling by railway adds a risk from the frequently recurring shocks of the vibrating motion of the train. This is of special moment if the journey is prolonged or repeated at short intervals. Of course this danger is greater in the case of women who have had premature interruption of the course of previous pregnancies.

Bathing and Care of the Genitals.

In regard to the taking of baths it must be said that a very scrupulous care of the skin is more necessary to the health of the pregnant woman than to that of any other individual. Whatever may have been the habit of any woman in the taking of baths, whether daily or less often, whether hot or cold, this may be continued when she is pregnant unless some complication arise to prevent.

The external genitals should be washed daily with clean water and a clean wash cloth. The use of so-called antiseptic drugs and lotions can do as much harm as good unless used for a positive indication and under medical advice. Internal douches also are to be used with similar precautions, and are neither necessary nor beneficial during the course of a normal pregnancy.

Much advice has been wasted in an effort to prevent trouble with the

breasts and nipples during nursing. Many of the proposed methods increase the difficulty rather than diminish it. The simplest means are the best. It is sufficient to rub the nipples gently with dilute alcohol once daily after a careful but not vigorous cleansing with clean water. If the nipples are retracted, the best "instrument" to draw them out is the clean fingers. In any case nothing should be done until two weeks before the date of expected delivery.

Care of the Breasts.

There is a distinct tendency to decay of the teeth during pregnancy. If any serious amount of trouble arises the teeth can be temporarily treated with soft fillings. A thorough inspection by a dentist should be insisted upon when the patient has regained her regular mode of life after the birth of her child.

Care of the Teeth.

The only drugs that might come under the head of household remedies in the case of pregnant women are the cathartics. The milder forms of laxatives alone should be used, and every effort should be made to regulate the action of the bowels by diet and regimen and the cultivation of a regular habit.

Taking of Drugs.

CHAPTER III.

PREPARATION FOR LABOUR.

The question of employing a physician or a midwife is hardly to be considered under the conditions prevailing in the United States. The so-called midwives of large cities in the United States are in great part an immigration from Europe, whence also the custom has been derived. There are practically no American trained midwives, and those who come from Europe are not of the first class as compared with the midwives of the Continental cities of Europe.

The choice of a nurse is of importance, and no final choice should be made without consulting the physician to be in charge. A good obstetric nurse must be a good nurse in the broadest sense, and should devote herself to this class of cases exclusively. She should abstain, at all events, from the care of any case of contagious disease for a considerable period before taking charge of a woman in or after confinement. The nurse should be engaged for some time in advance to come to the patient at her expected lying-in.

The Nurse.

The physician should be informed also at a considerable interval beforehand of his expected duty, in order that he may keep an oversight of the last months of pregnancy. Three methods of examination and

three causes for watchfulness on the part of the physician are indicated during this period of pregnancy, and a woman should neither worry about nor be shocked at such attention from her medical adviser.

The Physician: Methods of Examination.

These prophylactic measures are the following:

I. In order that a careful estimate of the development and size of the bony pelvis may be arrived at, it is necessary that an internal examination be made prior to the seventh month of pregnancy.

II. In order that labour may not begin while the fœtus is presenting in some abnormal position, it is necessary that frequent external abdominal examinations be made to ascertain the exact position of the fœtus.

III. Finally, it is essential that the urine of a pregnant woman be analyzed at regular intervals during the last five months of this period. These intervals may be fortnightly at first, and weekly during the last six weeks. These analyses are demanded in order that inflammation of the kidneys, which is the most insidious of all pathological complications, may be detected as early as possible, and the proper precautions be taken.

Surgical Appliances.

Every physician will have individual preferences as to the surgical appliances of which his patient should lay in a stock before an expected confinement. A number of dealers in surgical dressings in New York prepare so-called labour boxes, which are supposed to contain all that may be necessary during labour and the lying-in period. The following list, taken from such a box, will give a very good idea of them all: Two sterilized bed sheets sanitary pads); four dozen sterilized vulva pads (sanitary napkins); one four-quart douche bag, with glass nozzle; one zinc douche pan; two sterilized mull binders, heavy; five yards sterilized gauze; one yard ten-per-cent. iodoform gauze; two three-inch heavy mull bandages, sterilized; one pound sterilized absorbent cotton; one sterilized nailbrush; two twelve-inch papier-mâché basins; rubber sheeting, one and a quarter yard by two yards; rubber sheeting, one and a quarter yard square, rubber on both sides; safety pins; two ounces carbolized vaseline; one pint of saturated solution of boric acid; four ounces starch powder; four ounces fifty-per-cent. carbolic-acid solution; two ounces green-soap solution; two one-hundred-gramme bottles chloroform; one ounce fluid extract of ergot; one small bottle of bichloride-of-mercury tablets; one bottle sterilized tape.

The first two articles on this list may be homemade; the others must be obtained at some shop. The bed sheet is a gauze or cheese cloth bag and contains non-absorbent cotton batting; the finished pad is about one yard square and two inches thick. The vulva pads are twelve inches long, and are either made of sterilized gauze folded in six thicknesses, or

of absorbent cotton contained in a folded piece of such gauze. See *Nursing the Sick*, Chapter XII.

This list may be modified, expanded, or contracted at the discretion of any practitioner. In addition to these obstetric appliances it is hardly necessary to remind a young mother that her infant will need clothes as soon as born, and that they must be prepared beforehand.

A quiet, sunny, comfortable room should be selected as the lying-in and labour room. This room should be of easy access to a bathroom and water-closet. The labour room should be neither a dismantled, barn-like apartment, nor should it resemble a bric-à-brac shop. It is not necessary to disinfect an ordinary bedroom and try to convert it into a hospital operating room. Surgical asepsis and cleanliness are necessary, but they should be limited in their strictest application to the body of the patient and what comes into contact with her, and not foolishly applied to household articles, room, walls, and floors. The lying-in room should be bright and cheerfully furnished, with few enough pieces of furniture to be easily dusted and put to rights each day, and not demand too much time of the nurse to the neglect of her patient.

Labour Room.

The "labour bed" should stand with its head to the wall, both sides should be accessible, and preferably with the right side of the patient when lying on her back toward the light. A single bed is to be chosen if possible, although a double bed can be used without any very great inconvenience. A plain table for easy access to bowls of antiseptic solutions and to the obstetric dressings will complete the list of necessary pieces of furniture in the lying-in chamber.

Labour Bed.

The labour bed should be prepared as follows: If the spring is very yielding, a board like a cutting board should be placed between the spring and the mattress. A piece of rubber sheeting should be spread over the mattress and should be pinned in place with safety pins at the corners. A sheet should then be spread, and then a sheet called a draw sheet should be folded to reach across the bed and to stretch over the middle third only of the length of the bed, and should be pinned in position. On this draw sheet the protective bed pad of cotton batting and gauze should be placed, and the pillow and bedding to cover the patient will complete the bed-making. If these special bed pads are not at hand an efficient substitute may be made by folding an old sheet which has been boiled.

After the bed has been prepared the articles which will be especially needed at the time of labour should be arranged on the table near the bed and ready for use. The basins should be filled with a solution of corrosive sublimate (bichloride of mercury), in one of a strength of 1 to 2,000 for the hands, in the other of a strength of 1 to 5,000 for washing and

sponging the woman. The nailbrush should float in the first-named basin, and small wads of absorbent cotton in the second. Cut pieces of sterilized gauze about one foot square should be conveniently near for use about the woman, and the solution of boric acid, the starch powder, the vaseline, the safety pins, the tape for the cord, the ergot, and the binder and a vulva pad should be laid out ready for use. Finally, the douche bag should be filled with warm water about half full, and enough hot water be kept constantly on hand to fill the bag at short notice. Enough bichloride of mercury should be dissolved in a tumbler ready to be added to the water in the douche bag in order to make a final solution of 1 to 8,000. One of the ordinary tablets which makes a solution of 1 to 1,000 in a pint of water is the necessary amount to add to a full bag, or eight pints of water.

Arrangement of Articles Needed.

CHAPTER IV.

PARTURITION.

The mechanical expulsion of the fœtus is the result of a muscular act on the part of the mother alone. The child is passive, and has nothing to do with the act of parturition. The muscles which act to expel the child are primarily the uterus, and secondarily the muscles of the abdomen.

The term "mechanism of labour" refers particularly to the manner in which the child adapts itself to the maternal structures as it passes through the parturient canal. The regular mechanism is that by which the child is born head first into the world, and the unusual method is that in which the legs and buttocks are born first and the head last. There is still a third possible position in which the child may lie when labour begins—that is, transverse, or with the shoulder in advance. In the first class of cases the majority would be delivered without any assistance whatever, in the second class only a very small minority can be delivered without help, and in the third variety delivery is practically impossible till the child is turned about and comes either feet or head first.

Mechanism of Labour.

The act of labour is divided into three stages: the first, that of dilatation of the cervical canal; the second, that of expulsion of the child; and the third, that of delivery of the placenta or afterbirth.

Stages of Labour.

It has been already pointed out that the uterus sinks lower into the pelvis during the last two weeks of pregnancy. This is usually the first

precursor of beginning labour, and is followed by an easier respiration, a better digestion, and a power to walk more comfortably. The circulation in the lower parts of the trunk and in the legs is, however, interfered with to a greater extent than before, and these parts of the body become swollen. At times, also, the bladder and rectum are irritated by the descent of the presenting part of the fœtus and give symptoms. A viscid, yellowish fluid comes from the vagina and the uterus begins to contract regularly and rhythmically. These contractions may be painful, and recur sufficiently often to lead to a suspicion that labour is beginning. Such attacks are called *false labour*, and may last for an hour or two; they may occur even three weeks before true labour sets in.

When true labour does begin it is characterized by an increasing severity and an increasing frequency in the pains. During this first stage of labour the lower part of the uterus is dilating under the intermittent pressure upon its contained membranous bag, which, filled with fluid, envelopes the child. The pains of this first stage occur every three to ten minutes, are of a tearing character, and are caused by uterine contraction. The abdominal muscles take but little part in this process of dilatation. When the neck of the womb is fully dilated the uterine contractions cause the membranes to rupture, and the greater part of the contained fluid escapes with more or less of a rush.

The second stage begins, and immediately the character of the pains changes. The woman begins to use her abdominal muscles and to assist the uterus to expel its contents by straining and bearing down. The final phenomenon of the second stage is the stretching of the outlet of the parturient tract and the birth of the child. This final effort is the most painful of all, and is alleviated in skilled hands by the use of an anæsthetic.

During this process of dilating and stretching, the child is at all times passive, although used as a dilator in the second stage. While the neck of the uterus is being dilated by the pressure of its contained "bag of waters" the head of the child is being elongated and moulded by the pressure of the contracting uterus into such a shape that it will conform to the bony canal of the mother's pelvis. As soon as the waters break, the further dilatation is accomplished by the advancing head of the child. The advance of the head occurs during the contractions of the uterus, and is therefore intermittent. In the intervals between pains the head recedes, and at the next contraction advances again to a point beyond that reached during the preceding pain. During its progress through the parturient canal the head rotates in such a manner that when it has reached the outlet the face of the child points to the back of the mother, and the back of the head lies just under the pubic bone. During the final act in its birth the head rotates around the pubic bone of the pelvis in such a manner

Effect on the Child in Vertex Presentation.

that the child's occiput is stationary while the face is rotated upward—that is, extended until the external outlet of the genital canal is stretched enough to permit the passage of the head. The shoulders follow with the next contraction, one of them catching under the pubic bone as did the occiput, and the other rotating over the posterior edge of the genital opening as did the child's face. After the birth of the shoulders the hips and legs give no trouble and the child is born.

Effect on the Child in Breech Presentation.

When the child is born breech first the labour will go on more slowly than if the head is in advance; this is so because the softer breech is a poorer dilating instrument than the round, smooth, hard head. The fact that the child is being born by this unusual method may often be surmised before the breech appears at the vulva by the slowness of the case and by the discharge from the vagina of meconium, which is the blackish-green substance found in the bowels of the child at birth. In the case mentioned this meconium is squeezed out of the child by the pressure incident to its birth. When the buttocks finally reach the pelvic outlet, one hip catches under the symphysis and the other sweeps over the perinæum. From this point on the buttocks and legs, which soon follow, form a very good handle to pull on in order to hasten the delivery. As soon as the arms are born the head can be brought down by pulling on the legs until the occiput has caught under the symphysis, and then the body of the child must be carried up over the mother's abdomen till the face sweeps over the perinæum and the baby is delivered.

Delivery of the Placenta.

The third stage of labour is one of very variable length. Most obstetricians terminate it artificially by expressing the afterbirth, but there is no reason why it should not be left to Nature at least for twelve hours, barring, of course, the occurrence of hæmorrhage or some other complication calling for immediate interference.

Care of the Parturient Woman.

The parturient woman can be assisted in many little ways, but most of the real work must be done by herself. A skilled physician will be able to determine the progress of dilatation by means of internal examinations, and in the same way to fix more or less accurately upon the probable length of labour. An attendant who is unskilled in the matter of internal examination can do much harm and no good by attempts at such manipulations. It is better, therefore, to judge of the progress of the case by noting the times of occurrence of such prominent events as the breaking of the water bag, the change in the character of the pain from the tearing, cramp-like pains of dilatation to the straining pains of expulsion, and the visible stretching of the perinæum, with the appearance of the child's head at the vulva.

During the first stage of labour the woman should walk about and take fluid nourishment at intervals of three hours or so. She should take an enema of soapsuds and water and evacuate the bowel as early as possible, and should pass water frequently. She should be washed with soap and water after her enema, especially about the lower part of the abdomen, the groins, the hips, and the buttocks. This stage of labour should not last over twenty-four hours, and it may be much shorter.

During the second stage the patient should be in bed covered with a light blanket. Most women will be more comfortable on their side than on their back, and should get on their side in every case as soon as the head comes into sight; the danger of lacerations will be thus reduced to a minimum. This lateral position is such that the woman is on her left side; a pillow is placed between her knees, both of which are drawn upon the abdomen. The attendant should stay beside the patient's bed, and as the child is expressed should keep the parts thoroughly cleaned with a piece of sterilized gauze and solution of corrosive sublimate (1 to 5,000). During this critical time in the birth the attendant's hands should also be kept wet in the same solution, after having been cleaned in the manner described below. As soon as the head is born it should be supported in the hands of the attendant, who must be careful, however, not to hinder in any way the position that the head is forced to take. The shoulders will be delivered at the next pain, and this delivery will be accelerated materially by pressing the head against the perinæum until one shoulder appears under the symphysis pubis; then, as the pain causes advance, the head should be carried away from the perinæum, and the child will be easily delivered.

After the birth of the child one hand must be placed upon the fundus of the uterus, as felt through the abdominal wall, and should be kept there throughout the third stage of labour, or given to some assistant or nurse. When the child has been attended to as described below, the mother should turn on to her back, and the final procedure of delivery—that of the placenta—must be considered. This third stage may last twelve hours without harm, but usually it is over in an hour. During this stage the uterus will be felt as a hard oval body, with its rounded end at the level of the navel. It can be felt to grow harder at intervals of about five minutes, and it will be at one of these periods of contraction that the afterbirth is squeezed out. It is bad practice to attempt to deliver the placenta by pulling on the cord.

The first two stages of labour should be accompanied by no appreciable loss of blood. The delivery of the placenta, on the other hand, is always attended with some hæmorrhage. The amount of blood lost should not be more than about the bulk of the placenta itself, and should come away with the actual expulsion of the afterbirth. After the birth

of the placenta there should be no hæmorrhage other than a slight oozing. The question of severe hæmorrhages will be discussed hereafter.

When the third stage of labour is ended the mother should be washed with a surgically clean towel or piece of gauze, and a properly prepared pad should be applied to the vulva. The bed should be renewed by removing the soiled protective bed pad, and a fresh one put under the patient. If necessary, the draw sheet should also be replaced by a clean one. After the uterus has been watched by the constant presence of the hand upon the abdomen, and has been felt to remain as a hard round ball with its upper limit at or below the navel for an hour, an abdominal binder can be applied and the patient left to herself. (See *Nursing the Sick*, Figs. 28, 29, 30, 31, and 32.) She should be on the back, with the head low, and sleep if she can. She may receive some light nourishment before settling down.

Antisepsis.

The main factor in the question of antisepsis and asepsis is *cleanliness*, but the kind of cleanliness meant is a peculiar one; it is a cleanness or freedom from the special germs which have been proved to be the cause of the most virulent complication of labour—*puerperal fever.* To avoid the risk of such infection all articles that are to come in contact with the parturient canal of the woman must be freed from these living germs or their spores. The articles to be so treated are all the obstetric dressings, all gauze and absorbent cotton for washing the patient, the bed pads which are to protect the bed from the blood and other discharges, and all instruments and apparatus. *The most important of all the articles needing disinfection, or sterilization, as it is called, are the hands of the accoucheur.* In addition, the woman herself must be cleansed in all suspicious parts from which an infection may arise. Finally, the navel wound of the baby must not be neglected, and the same rules of surgery apply here. Sterilized tapes for tying the cord and germicide washes for the mouth and eyes are necessary safeguards against infection of these parts.

The method in which this sterilization is done is immaterial, so that it is effective. The efficient germicides for sterilizing all instruments and surgical dressings are heat applied as live steam or as boiling water, and certain chemical antiseptics. The hot water or steam is the better of the two. The heat is applied so hot that it is impossible to use it for living tissues—the hand, for example. All dressings and gauze and all instruments are to be exposed for one hour at least to the action of boiling water and its escaping steam. The protective bed pads, towels, gauze, and similar stuffs are sterilized best by exposure to steam under pressure, and all hospitals and dealers in surgical supplies have special apparatus for the purpose. The sterilization of such cotton materials may be done in an emergency by boiling them for an hour in a clothes boiler, or for

smaller articles in a fish or asparagus boiler. A very excellent and inexpensive sterilizer is made by the Arnold Steam Sterilizer Company, in which the articles to be sterilized are exposed to live steam. See *Nursing the Sick*, Fig. 14.

After being sterilized, the various articles should be wrapped in towels, which have been treated to the same process, and the packages should be pinned and put one side except they be needed for immediate use.

The disinfection of the woman should consist simply of a thorough cleansing with soap and warm water of the lower part of the abdomen, the groins, the upper parts of the thighs, and especially the buttocks and the external genitals. This washing should be done as soon as labour is fairly begun, and should be repeated if the bowels move or if the patient passes water. After labour is ended the same washing should be repeated, with especial care to remove all clots and stains of blood, and the proper obstetric pad applied to the vulva.

Last and most important, the hands of the attendant must be rendered surgically clean. To accomplish this the sleeves should be rolled up to bare the arms to the elbow, all rings should be removed from the fingers, and the hands should then be washed with soap, hot water, and a nailbrush. After the hands have been washed once, the nails should be cleaned by scraping under them with a blunt instrument, preferably one of wood (ivory and bone nail cleaners are fair and metal knife blades are bad). A second and more thorough washing should follow during which the skin is scrubbed as high as the elbow, but the nails receive the greatest attention. Such a final scrubbing should last at least three minutes and should be followed by a rubbing with alcohol and nailbrush, and finally, and least important, by similar treatment with some chemical disinfectant. Cf. *Surgical Injuries and Surgical Diseases*, p. 444.

The chemical disinfectants may be powerful germicides, but they are poisons, and they require an appreciable interval of time in which to act. The benefit derived from their use has been magnified by their popularization. They are an excellent aid to disinfection, but can not be used with success to the exclusion of ordinary cleanliness. The best drug of this class is the corrosive sublimate (mercury bichloride). It is to be used for the hands in solution of a strength of 1 part to 2,000 parts of water. After the hands are thus prepared they are to touch nothing except other sterilized objects; great care and a habit of avoiding such contamination are necessary to guard absolutely against it. The common errors in this regard are to dry the hands on a towel, to scratch the face or, worse, the head, to handle the bedclothes of patients, or various pieces of furniture. The hands should be wet in the corrosive-sublimate solution at all times when in use, and should be washed in the same thorough manner whenever they become contaminated by contact with unsterilized objects.

The methods of applying these same principles to the eyes, mouth, and navel of the child are to use a saturated solution of boric acid to wash out the mouth and eyes, and to powder bismuth or starch powder on the navel.

CHAPTER V.

CARE OF THE NEWBORN CHILD.

THERE is a widespread opinion among the laity that some serious legal responsibility is assumed by any one who separates a newborn child from its mother by cutting the umbilical cord. Such is not the case; any one may care for these patients in this emergency, and the doing the right thing at the right time will save the lives of certain children.

As soon as the child is born the mother may be temporarily left, or some one else may hold the hand on the abdomen and top of the uterus while the child is attended to. The umbilical cord should be felt, and if it is pulsating no great hurry will be necessary. The child should be picked up and held in one hand with the back up and the belly down, until it cries strongly.

FIG. 1.—CUTTING THE UMBILICAL CORD.
a, *b*, the line of division.

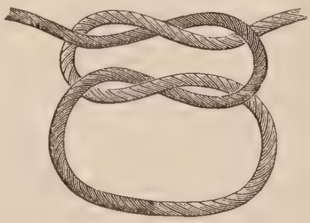

FIG. 2.—REEF KNOT (After Wyeth.)

The child's eyes should be washed with the saturated solution of boric acid, and the mouth wiped out with the finger, on which is spread a piece of linen wet in the same solution. As soon as the cord stops pulsating it should be tied in two places—one about an inch and a half distant from the navel, and the second at least two inches farther from the same point. The cord must be cut between the ligatures and the portion attached to the child must be carefully inspected to see that it does not bleed.

Tying of the Umbilical Cord.

Fig. 1 represents a newborn child lying on its back with the cord

and afterbirth attached. Two ligatures have been applied to the cord, and the line of division is indicated by the line *a b*. This figure is intended to illustrate how properly to divide the umbilical cord, and not the proper position of the child before the cord has been cut. For the sake of convenience, therefore, the child is represented as on its back and not on its side, and the afterbirth as already delivered, although the placenta is rarely born until an appreciable interval has elapsed after the cutting of the umbilical cord. The cord should be tied with bobbin about an eighth of an inch in width and which has been sterilized as described above. The knot in this bobbin should be a regular square or sailor's knot, and each part of the knot should be drawn tight enough to begin to cut into the jelly-like substance of the cord. Fig. 2 represents the making of a square knot.

Primary Respiration.

As soon as born, and before the cord is tied, most children begin to breathe and to cry more or less loudly. The first respiratory act is an inspiration, and the method of holding the child just described—*i. e.*, never on its back—must be continued for some time, in order that the mucus and secretions which are in the throat and mouth may not be sucked into the lungs.

RESUSCITATION OF APPARENTLY STILLBORN CHILDREN.

If respiration is delayed, or the crying is not vigorous even after the cord is tied, the child must be stimulated to better efforts. This is done by stimulating the skin of the child by spanking sharply with the hand, by rubbing the back with whiskey or alcohol, or by alternate hot and cold applications to the spinal column and chest. The heat may be applied with hot water, the cold with a piece of ice or cold water. In using friction with hot and cold water care must be taken not to depress too much with cold applications, and it is wise to give the baby after such treatment a hot mustard bath when it begins to breathe, and while still red from this treatment to wrap it up in a hot blanket and place hot bottles about it. Blowing into the mouth and face of the child will tend also to cause a reflex gasp. The mouth of the attendant can be placed directly upon that of the child and the lungs partly inflated by blowing. When this is done the nose should not be held, in order to leave a safety valve and not to exert too great a pressure on the lungs. On the other hand, the abdomen should be gently compressed with one hand in order that the air thus introduced may not go into the stomach but into the lungs. Such active efforts should not be repeated too frequently; about three times per minute is often enough, while the rubbings and spankings are continued in the intervals. If the child does not begin to breathe after a fair trial of two to three minutes' duration of the methods just detailed, no further time should be lost, but artificial respiration (Sylvester's

method) should be begun in the same manner as detailed in the article in this volume on *Medicines and Treatment.* The child must be laid upon the back and a renewed effort to cleanse the pharynx of mucus must be made by inserting the finger covered with gauze wet in boric-acid solution. The child should be covered to its armpits with a soft woollen blanket and surrounded with hot bottles; the head and shoulders should be slightly elevated. The forearms are held just below the elbow and are brought above the head as high as possible and pushed backward in this position. (See *Medicines and Treatment*, Fig. 13.) In this manner air is drawn into the lungs and an inspiration is the result. The arms are then lowered to lie beside the chest and are pressed against it, thus forcing air out of the chest. (See *Medicines and Treatment*, Fig. 14.) These movements are made alternately; the cycle should last four or five seconds. The tendency of a beginner is to hurry the rhythm of such a procedure, so that it is wisest to control the performance of it by the constant observance of the second hand of a watch. If success is to attend one's efforts the child will usually show some sign of spontaneous breathing within ten minutes, and the beating of the heart and the pulse will become regular and stronger even before the respiratory act is established. The artificial respiration must be continued in unfavourable cases until the heart stops, and in favourable cases during shorter periods with increasing intervals until the child breathes regularly and has cried strongly.

Artificial Respiration.

After the child's vital functions are fully established it should be wrapped in wool, surrounded with hot-water bottles, and laid in its crib or in a big chair. Before leaving the child the cord must be inspected, to see that it does not bleed, and then the attention of the attendant can be given again to the mother and the necessary care during the third stage of labour, as has been detailed above.

When the mother has finally settled down for a sleep and the room has been tidied, the further care of the child may be resumed. If this stage of the case comes at an inconvenient hour in the middle of the night the baby may be left till morning, except in two particulars: the skin should be thoroughly smeared with an oily substance (vaseline or olive oil) in order to soften the white sebaceous matter on the surface, and the cord should be again inspected to see that the ligature is tight and that there is no bleeding. If at any time the cord begins to bleed, a fresh ligature must be applied. While waiting for the ligature any serious hæmorrhage can be entirely controlled by squeezing the cord with the fingers.

The next thing in order for the infant is a bath. This should be given before an open fire, except in midsummer, and in a portable tub long enough for the baby to lie at full length. The water should be about four inches deep and of a temperature of 100° Fahr. The infant should

be sponged gently with soap and water to soften and remove the sebaceous matter and the vaseline which has been rubbed on the skin; it

First Bath.

should then be placed in the water in such a manner that one hand supports the head and neck by putting the back of the shoulders in the palm, with the fingers in one armpit and the thumb in the other, while the free hand washes off the soap with a small sponge. The bath should last about three minutes. The baby is then dried and the skin is powdered with a starch powder. Especial care must be given to the armpits, the groins, and the folds of the buttocks to see that they are dried and well powdered. The umbilical cord should be dusted over with the starch powder and enveloped in absorbent cotton, which should be held in position by means of a flannel band. The flannel band should be about forty inches long and six inches wide, so that it will surround the abdomen and lower part of the chest of the child. This band

Clothing.

should be sewed on by a few stitches. The remaining clothes will vary according to the ideas of different mothers. A common set of clothes for dressing infants consists of a light woollen shirt worn over the band; then, in order of application, a diaper pinned with safety pins in triangular form; a flannel petticoat or barrow-coat wound around the abdomen and chest and pinned in place. The barrow-coat reaches down a foot or more below the child's legs and is turned back over the legs and pinned. A simple slip a yard and a quarter long, extending well below the child's body, and woollen socks to protect the feet complete the outfit.

After the child is dressed it should be put to the mother's breast in order that it may suck out the laxative secretion called *colostrum*, which

First Nursing.

is usually to be found there. The child should then be rolled up in a blanket of thin flannel or knitted wool, which may come up over the neck and back part of the head, but should leave the face free, and which should confine the arms by binding them to the body. The child thus protected should be placed in a bed by itself and on its side. Its legs should be further covered in cool weather with a light woollen blanket. Usually the child will go promptly to sleep.

A separate bed, either cradle or crib, or an improvised affair made from a clothes basket, must be provided for the infant, who should never

Arrangements for Sleep.

sleep in the bed of its mother or in that of any other adult. This separate bed must be insisted on because of the danger that the sleeping mother will push the child out of bed, or roll on it and suffocate it, and principally because in such a bed the child does not get a sufficient amount of fresh air, and lies in the bottom of a tent formed by the grown person's shoulder and the bedclothes. The child's crib should not be shut in with curtains either to protect from draughts or to protect from the light. A child grows to

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have the habits which are taught it; it is born to learn, and it begins the process at once. If the sleeping child is kept in a darkened room in which no one speaks above a whisper the child will soon acquire the habit of sleeping only under such conditions. If the child is sung or rocked to sleep, or is allowed to suck its fingers when going to sleep, these habits will be formed and will subsequently be broken with difficulty or not at all. The child should be taught by constant repetition to go to sleep alone, lying in its bed, in the light by day and in the dark by night.

It is wise during the first week of life not to give a full bath until after the dried umbilical cord has separated from the navel. The baby during this time should be sponged off with warm water and have clean clothes put on every morning. The stump of the cord separates usually by the seventh day and leaves the navel dry and healed, or the navel becomes so after a short period of treatment with bismuth powder. The cord should be left to separate of itself, being powdered each morning with starch to keep it dry and wrapped in clean absorbent cotton. If any odour or any secretion of pus develops about the cord, a drying powder of bismuth, or bismuth mixed with iodoform, should be dusted on the navel.

Care of the Cord.

During the first two months of life the baby should live in a perfectly routine manner. It should be fed at regular intervals, should be awakened during the day for this purpose, and allowed to sleep at night as long as it will. In this way it soon learns to wake at the regular times and to sleep at night for periods of six to ten hours. It is not cruel to the child to wake it for food, nor will this systematic feeding make the child "nervous." On the other hand, nothing is more cruel to the mother than to bring her an infant to nurse every two hours through the night as well as the day.

Routine Life.

Another habit which must be taught the child as soon as possible is in reference to the action of the bowels. During the first week the bowels discharge the dark slimy meconium which fills them; as soon as the milk diet is begun the stools gradually become yellow, soft, and smooth, and are repeated two to four times a day. As soon as the child is three months old it should be made to sit on a small commode chair at the same time each day, and will soon learn to have regular passages. As often as the diaper is wet from urine it must be changed and a fresh one applied, after thoroughly drying the parts and powdering them freely.

Bowels.

A bath must be given each morning in the manner described, and the face and hands should be sponged off every night before the last nursing. The regular bath should be given when the baby's stomach is empty and just before a regular feeding time. After the baby is dressed and has had a meal it will usually go to sleep.

Daily Bath.

The special cleansing of the eyes and the mouth with saturated solution of boracic acid should be a part of the morning toilet.

There are two unusual symptoms seen at times during the first week of life. One is a swelling of the breasts of the child and a secretion of milky fluid; the second is a mild hæmorrhagic discharge from the vagina of girl babies. The second requires no treatment; the first may need surgical care, and in any case such swollen breasts should be stuped with hot boracic-acid solution.

Infantile Mammary Secretion.

The newborn baby can begin to go out of doors only when the weather is fairly warm. The interval that should elapse between the birth of the child and the time for going out naturally will be longer in winter and shorter in summer.

First Outing.

CHAPTER VI.

LYING-IN PERIOD.

After labour is finished and the woman has been washed and has settled down for a rest nothing need disturb her for an hour or more. The uterus will continue to contract rhythmically for a number of hours—twelve to thirty-six in different cases. These contractions may be severe enough to be painful, and thus cause the so-called afterpains. Afterpains are less severe after the birth of the first child than after subsequent labours. They are especially severe if any blood clots collect in the uterus, and are increased by the taking of cold drinks, by the act of nursing the baby, by any pressure over the uterus, or by the filling up of the bladder or rectum. These painful contractions of the uterus may be repeated as often as every half hour at first, but the interval between the pains increases, and the severity of each pain gradually decreases until they cease altogether on the second or third day after labour.

Afterpains.

At the time of labour there is a loss of considerable blood following the birth of the child and accompanying the delivery of the placenta. This flow of blood continues for a varying time afterward, and is at first bright red and quite profuse. Later it becomes darker in colour and less in amount, and finally changes to a colourless mucous discharge. It ceases as a continuous flow at the beginning of the second week, but recurs at intervals for two weeks more, especially after exercise, walking, etc. The lochia, as this flow is called,

Lochia.

have an odour which is peculiar to themselves, and should not be foul or fœtid in any sense.

Involution of the Uterus.

The uterus begins at once to retrograde and to diminish in size. The rate of diminution is of such a nature that the top of the organ descends from the neighbourhood of the navel just after delivery till it reaches the level of the pubic bone about the fourteenth day. It has returned to its normal size by the end of the second month. This shrinking or involution of the uterus is the best guide as to when the patient should leave her bed and begin to walk about. She should not do so until the lochia are absent most of the time and the height of the uterus corresponds to the pubic bone. The remaining characteristic feature of this period is the establishment of the flow of milk. This is described in detail in the next chapter.

General Health.

During the puerperal week the patient should have a normal temperature, her pulse should be slow—even slower than normal—she should feel well, and have a good appetite. She is apt to continue constipated after labour, but will pass more urine than usual.

Care of the Puerperal Woman.

During the first week after confinement the woman and the baby should lead a very regular mode of life. The nursing should be regular, and during the intervals the baby should sleep. If the baby does not sleep at night it is well to keep it in an adjoining room and take it to the mother only at nursing time. The mother should have a sponge bath every morning and should be given a generous diet of solid food at all times. She should not be kept on slops and fluids even for the first twenty-four hours. Milk is a good food for these women; it is a stimulant to the kidneys, easily digested, and easily procured in a condition of purity, but a milk diet to the exclusion of all else is not a desirable form of diet for a parturient woman. Such a woman should eat three good meals a day, and should take in addition some fluid nourishment between meals and during the night. Milk, squeezed beef juice, and broths are good for these extra feedings.

Antisepsis.

As often as the absorptive pads on the genitals become saturated with the lochia they should be removed and replaced by fresh ones. The process of changing these pads should be undertaken only with a strict observance of surgical cleanliness or asepsis; the hands of the attendant should be cleansed as above described, and the fresh dressing should be carefully handled so that it may not come in contact with any object between the time it leaves its aseptic receptacle and is placed on the woman. The genitals should be cleaned by washing externally with mild antiseptic fluid (corrosive sublimate, 1 to 5,000). Internal douching of the parturient canal should be done only for a very

positive indication and under the direct supervision of a physician. The douching of the vagina at regular intervals has been proved to do more harm than good and should be omitted from routine practice.

Bodily Functions.

The bowels should be moved artificially on the third day, preferably by enema of soapsuds and water. If there is any febrile reaction at this time a saline cathartic is indicated. The patient should use a bedpan during the first week both when moving the bowels and when passing water. After that time she may use a commode for the purpose. The bedpan is a disagreeable necessity to many women, and some can not pass water at all in a dorsal position. If the patient does not urinate during the first eight hours after confinement she should be aided to do so by the application over the bladder of cloths wrung out in hot water. If this fail it is well to allow her to try to empty the bladder by sitting on the commode. This will usually be successful unless the upright position causes her to feel faint. Of course such a woman should not be left alone in the sitting posture, and should be put back to bed immediately on the appearance of any untoward symptom. The last resort is the passage of a catheter into the bladder. (See *Nursing the Sick*, Fig. 15.) This little operation should be done by sight alone, and with the most careful antiseptic precautions both for the hands of the attendant, for the woman's genitals, and for the instrument itself. The method is described in the article on *Nursing the Sick*. It had better be left to skilled hands than be attempted by the inexperienced.

Temperature and Pulse.

A routine record of the temperature of the patient should be taken with a clinical thermometer in the mouth every morning and evening. The pulse-rate per minute should be recorded at the same time.

The patient should not receive many visitors during her stay in bed. At first the list should be limited to the members of her immediate family; their social calls should be short, and should not be made by more than one or two at a time.

Sitting up, Walking, etc.

The patient may move about the bed after forty-eight hours, and can begin sitting up in bed at the end of a week. She may get out of bed during the third week as soon as the uterus has involuted to such an extent that it is below the pubic bone. When she first gets up she should lie down on a sofa at frequent intervals; she may begin to take a few steps about the room and can go downstairs about a month after labour, and may go out for a short walk or drive as soon as downstairs. If the patient lives in an upper story she should not attempt to climb a large number of steps for a number of days after she first goes downstairs. She should be carried up for the first few times, and assisted up for a number of times more before doing the average amount of stair-climbing incident to life in a city

house. In getting about again after confinement it is far wiser to do too little than too much. It is better to be up one hour twice with a sufficient rest in between, than to be about for two hours once. The greatest difficulty is to make women understand that they are not the proper judges of their own powers of endurance and of doing work.

CHAPTER VII.

LACTATION.

The condition and appearance of the breasts during pregnancy has been described already. At the time of labour they are in the same condition as during the last months of pregnancy. No marked change takes place in them until after the birth of the child. About the third day (forty to sixty hours) after labour there is a sudden increase in the size of the breasts, which become also more firm and somewhat tender. This swelling makes the nipple relatively more flat and more difficult to be grasped by the infant's mouth.

Beginning of Lactation.

The general condition of these patients varies; there may be no symptoms at all, or the patient may feel quite ill. In the severest cases she will have a quickened pulse and a slight rise of temperature; a headache develops; her face becomes flushed; she feels hot and may perspire profusely; at the same time a distinct thirst increases her annoyances. Milk fever is an old term to express this condition, but, as is shown below, the milk fever of thirty years ago (and which still exists in the catalogue of diseases of the laity) was more often a mild grade of puerperal fever than any special morbid process connected with the beginning of lactation.

Milk Fever.

The question whether a woman should nurse or not is one which is, theoretically, easily settled; practically, however, many factors must be considered both from the point of view of the woman and from that of the child. Lactation is a distinct advantage to the mother during the first puerperal month. The mammary irritation due to the sucking increases the contraction of the uterus and accelerates its involution. The necessity for increased food for a nursing woman will stimulate all her tissues to greater activity, and especially to the putting on of fat.

Effects of Lactation on the Woman.

As far as the child is concerned there can be no doubt but that good breast milk is the best food for a newborn baby. Poor breast milk, how-

ever, is as bad a form of nourishment as any poor artificial food. The best evidence that any particular child is receiving good and sufficient food is to be found in the child itself. As long as the baby increases in weight it is probably doing as well as could be wished for. The child should be weighed every week during the first twelve months of life to determine whether the food is agreeing with it or not.

Result of Lactation for the Child.

The baby should be put to the breast every two hours for the first week of life, except at night, and should be wakened in the daytime in order that the proper routine be established. After the first week, and until the sixth week, the intervals may be lengthened by counting the two hours' interim from the end of one nursing to the beginning of the next. At six weeks the intervals should be made three hours, including the time consumed in the act of feeding, and should be kept at this point during the succeeding six or seven months, or even to the end of the first year.

Frequency of Nursing.

The amount of milk that a child should take at each feeding varies with the age of the child. At birth the stomach of an infant will contain one ounce; the capacity of the stomach increases rapidly, and within ten days this organ will contain double this original quantity. At six weeks of age the stomach will hold from three to four ounces, and this amount should be given at each nursing. The increase is gradual after the second month, and the amount given each time should be gradually increased until at six months the child is taking six ounces, and at nine months eight ounces of fluid at each feeding.

Amount of Milk for Nursing Babies.

It is a general rule that a baby of any age will get the proper amount of milk from its mother's breast in a period of nursing of about fifteen minutes' duration. The mammary glands will regulate and secrete the amount which is necessary very accurately. When lactation begins the breasts secrete less milk than they do at a later period, and the amount is gradually increased to meet the changing demands of the infant upon them.

If there be any deviation from the rule that the supply of milk equals the demand, the first and most trustworthy witness thereof will be the baby. If the baby gets too little food it will cry soon after being fed; it will try to put things into its mouth, especially its fingers, and it will not gain in weight at the normal rate of five to nine ounces per week. If the baby is fed too abundantly it will vomit the milk, not only directly after feeding, but at the end of the period of fasting and just before the next feeding is due.

Insufficient and Excessive Feeding.

Many babies regurgitate a small amount of milk immediately after nursing, especially if they are handled much and danced up and down;

the milk thus spat up is usually sweet-smelling and not curdled. Acidity and sour-smelling curdled milk is characteristic only of milk which has been in the stomach for some time. The natural process of digestion causes such a curdling, and the occasional vomiting of sour milk is not necessarily a sign of a deranged stomach. But when vomiting occurs more or less regularly, and at the end of the interval between nursing, it means that the stomach was not emptied as it should have been when the next nursing began.

Further symptoms of overfeeding are hiccough, colic, and the appearance of white lumps of undigested milk in the stools. Hiccough is rarely a symptom of any special significance, but colic and lumpy stools may be the precursors of serious diarrhœa.

Infantile Colic and its Treatment.

The crying of an infant with the pains of intestinal colic is accompanied by the further symptoms that the legs will be drawn up on the abdomen, that the child will squirm around and be restless, will bite at its fingers, and will become pale even to blueness about the lips. These symptoms recur with marked severity at intervals of two to five minutes, and the whole attack may last for hours. Crying alone in babies is no evidence of colic; they always cry when hungry or when uncomfortable from wet or soiled diapers.

The treatment of the attacks of colic is to apply heat to the abdomen by wrapping the child up on a hot-water bag, or, better, by giving a hot mustard bath to the whole body. In addition, the child can be given hot water to drink. As to drugs, they are best given only on the orders of a physician. The teas made from plants containing essential oils, such as peppermint, fennel, anise, or chamomile, have the best reputation. *Laudanum and other opium preparations are very dangerous for children, and even paregoric is to be avoided.*

The preventive treatment of colic consists in finding the direct cause—whether overfeeding or underfeeding, or improper milk, or what not—and of removing it. The amount of milk taken with each nursing and the intervals between feedings must be carefully investigated, and all errors tending to overfeeding or to underfeeding must be corrected. This can be easily regulated in babies who are on the bottle. But the amount taken at each feeding by nursing babies can be decreased or increased only by changing the duration of each nursing.

Care of the Breasts.

The nipples may be rubbed during the last two weeks of pregnancy with dilute alcohol once a day in order to harden them. When the baby is born it should be put to the breast to suck even before the milk comes. This should be done about every four hours, and will accomplish two things: first, it will give to the baby the laxative colostrum which is in the breast, and, second, it accustoms the nipples to use before the milk rushes in and distends the

breast, thus rendering the first attempts at nursing more difficult by making the nipples flatter than before.

Before each nursing the nipples must be softened by rubbing with a small piece of absorbent cotton wet in boracic-acid solution; this will cleanse the nipple and will cause it to bear the pulling of the child without cracking. The rubbing will stimulate the nipple to erect itself and give the baby a better chance to take hold. Between the nursings the nipples should be powdered with bismuth or starch powder and kept dry.

In the cases where the nipples prove to be tender and painful, and especially when they become actually cracked, the use of a *nipple shield* will be a great comfort and allow the nursing to be done painlessly until the nipples are tough enough to be used without this aid. The best nipple shield is that devised by Dr. Ware (Fig. 3) in that the side tube allows the mother to assist the infant if it is weak, and also to diminish the suction force by letting air in behind the feeding nipple when the child is too strong. The instrument is of glass and soft rubber and should be kept in the solution of boracic acid when not in actual use.

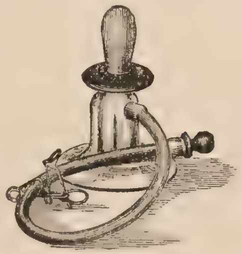


FIG. 3.—A NIPPLE SHIELD.

Caked Breast and its Treatment.

At the time of the onset of the flow of milk into the breasts these glands may become "caked," as it is called, and the condition known as "milk fever" be set up, the symptoms of which have been described. The proper treatment of this condition is, first, to give a saline laxative, and, second, to apply to the breasts stupes of very hot water. Each stuping should last about ten minutes and should consist of the application to the breasts of flannel cloths wrung out in boiling water. These cloths are to be laid dripping wet in a towel and wrung out by twisting the towel. About ten such cloths should be used—that is, two cloths used alternately five times each. Such stuping should be repeated every two to four hours.

Between the stupings the breasts are to be bandaged or bound up. A breast binder should be applied in such a manner that the breasts do not drag by their weight from their attachments to the chest wall. A very excellent binder for the purpose is the double Y (see *Nursing the Sick*, Fig. 33), which, when in position, causes the breasts to be approximated to each other and pulled up toward the middle line of the body, and also toward the upper part of the chest. The breasts of a woman lying on her back gravitate toward the abdomen, and more particularly toward the armpits. The binder must overcome this tendency. When properly applied, the double Y-binder accomplishes this end without the necessity of pads of cotton, and permits the child to nurse without its being removed.

Diet of Nursing Women.

The diet of nursing women must be nutritious and easily digested. Some women will find that certain articles of food must be avoided because they affect the milk and give the baby colic. Each case must be judged on these points for itself, and no absolute rules can be formulated. In general, it is wise to take plenty of fluid, and to take some light nourishment between meals and once during the night. A glass of milk or the juice of half a pound of beef with a little bread are excellent forms of food for this purpose.

Every healthy woman should nurse her infant for one month, if possible, entirely for the benefit to be derived by herself. She should nurse longer, and for as much of nine or ten months as she can for the benefit of the infant.

Weaning.

A baby should be taken from the breast and put upon artificial food by the time it is ten months old. At this age it is able to digest cow's milk, also certain preparations of meat, and the various cereals and prepared starchy foods. In changing from one method to the other it is best to do so suddenly so far as stopping the breast feeding is concerned, but gradually so far as trying the various kinds of food just enumerated. This means that the child will be given during its seventh, eighth, or ninth month an occasional meal of barley water and milk, of various gruels, or even some of the proprietary foods—Mellin's Food or Imperial Granum, for example. A general rule should be laid down that only one new article of diet shall be given during any one period of forty-eight hours. In this way any difficulty of digestion or any tendency to diarrhœa will be very easily and correctly ascribed to the proper cause—that is, to the innovation.

A child of six months should begin to learn to drink from a spoon and from a cup, and should be taught thoroughly to do these things before weaning is attempted. Such children should drink water and also the diluted cow's milk which it is proposed to give them when the final break is made. If the child makes a great fuss and fights the new order of things, it is wise for the mother to leave it temporarily, and it will soon give up and eat.

The breasts should be made to dry up as soon as possible by binding them tightly and then leaving them alone. Pumping them out and rubbing them will relieve them for the moment, but they will harden and swell up again in a short time. These uncomfortable feelings can be alleviated by hot stupes given as described on a preceding page of this chapter. Women about to wean a baby should take a mild laxative and should diminish the amount of fluids in their diet.

Of the various foods for infants at the weaning period, the best to begin with is cow's milk diluted with one fifth limewater and slightly sweetened. If this temporary food is digested well, it is wise to keep it up for

a few days and then to try the cow's milk pure. After a week or ten days some one of the starch preparations should be given, and then after a similar period another, and finally the juice of squeezed beef and soft-boiled eggs. A child a year old can be fed three times a day on these fluid and semisolid things until it has cut its teeth, or at least the first sixteen. It can then receive bread, meat, potatoes, cooked fruits, in addition to milk, gruels, beef juice, etc.

Wet Nurse.

If a woman can not nurse her baby from any cause, the question of putting the child on a wet nurse or of giving it artificial food arises immediately. The reasons why a woman can not nurse may be either because her general health forbids or because something has happened to the milk supply. She may be suffering from an organic disease of the heart, lungs, liver, or kidneys of so serious a nature that she can not endure the strain of nursing. Women who are ill with tubercular disease, even of an incipient character, of any part of the body, but more particularly of the lungs, should not nurse, both for their own good and for the baby's. Certain women have no milk at all, or the mother's milk may cease to agree with the child at any period of lactation. After the sixth month most children will thrive on artificial food if it is necessary to wean them from their mother. Before the sixth month the necessity for a wet nurse will be more urgent in proportion to the lack of vitality and to the growth of the baby. The artificial food should be given a trial even if the crisis arises during the first week of life. A wet nurse is indispensable in certain cases of weakly infants, but should be held back as a last resort in all cases. In the case of sick children the securing of a wet nurse should not be postponed until it is too late to save the life of a child. In the case of healthy, strong children, the preference is given to artificial feeding because proper nutritious food can be easily prepared by modifying cow's milk (because wet nurses are the most difficult of servants), and because wet nurses are liable to the same faults as regards their milk as are the mothers themselves, although to a less degree.

Choice of a Wet Nurse.

A wet nurse should be chosen by a physician and only after a careful physical medical examination, which should be of the same nature and equally exacting as the regular examinations given by physicians to candidates for life insurance. In addition, the condition of the breasts and of the milk must be investigated, and, most important of all, the present condition of the nurse's own infant must be thoroughly examined to determine evidences of disease and retarded development.

The proper modification of cow's milk will solve the problem of the correct food for any given baby. The milk of the ass and that of the goat are expensive, and are not of practical importance in this country

at least, although both have been used and recommended highly in France.

Cow's milk differs from human milk in containing a less quantity of milk sugar and a greater quantity of curd or casein, which is of a more lumpy consistence when coagulated. The first difficulty with the casein may be overcome completely by dilution; the second will be modified by the same process, and will be modified further by the character of the diluent. If cow's milk be diluted with alkaline fluids, such as lime-water, or with boiled starchy fluids, such as barley water, its casein will precipitate in the process of digestion in thinner curds than is usual.

Artificial Food.

Commercial cow's milk varies further from human milk as delivered directly into the mouth of the child in having an acid instead of an alkaline reaction, and in containing a greater or less number of bacteria, whereas all milk is delivered from the secreting gland in a sterile condition. The acidity should be neutralized by the addition of an alkali, and the limewater already spoken of as a diluent for the casein will accomplish this neutralization.

The removal of the bacteria is accomplished not by actually removing them but by destroying them. The process of destruction may be by heating the milk to the boiling point in a closed vessel, and is known as *sterilization*, or by heating the milk in sealed vessels to a temperature below boiling, but which is high enough to destroy the germs and most of their spores. This process is called *pasteurization*. Applied to milk, the pasteurization is accomplished by heating to 168° Fahr. for a period of thirty minutes.

Perhaps the best method of preparing artificial food for infants is that detailed by Dr. Holt in his *Cathechism on the Care and Feeding of Children*. To prepare twenty-four ounces of food he allows a quart and half a pint (forty ounces) of milk to stand in a high milk bottle for six hours, and removes the top eight ounces (half a pint); he secures in this manner a cow's milk which contains an excess of cream or fat and the amount of casein normal for cow's milk. He dilutes this top milk with twice its volume of barley water, and secures thus a cow's milk containing the amounts of casein and of cream which are normal for human milk. He has in addition so modified the conditions that the casein will coagulate in fine flocculi and not in large masses.

Barley water is made by boiling a quart of water and two tablespoonfuls of barley for six or eight hours, straining through a cloth, adding salt, and replenishing the water as it boils away. A quicker method is to cook two teaspoonfuls of Robinson's prepared barley flour in a pint of water for twenty minutes.

It only remains to add sugar to the diluted cow's milk already de-

scribed, and in the case cited Dr. Holt does this in the proportion of six heaping teaspoonfuls of milk sugar. In this manner a food is supplied which is suitable for most healthy babies for any age up to eight months.

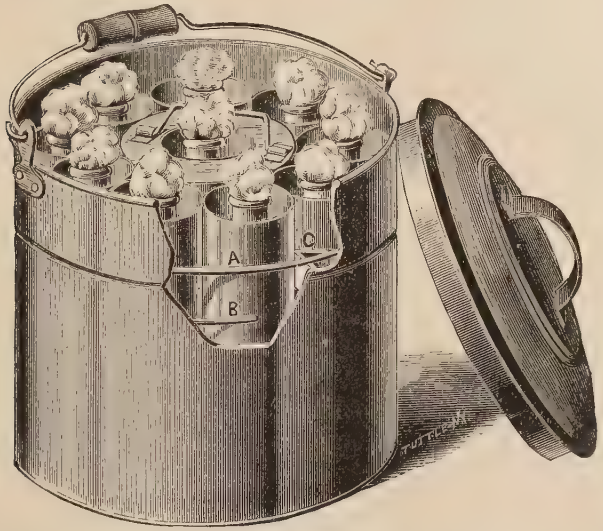


Fig. 4.—Freeman pasteurizer arranged for heating the milk before the pail is covered.

The total amount needed will vary according to the age of the child and to the amount necessary for each feeding and to the number of feedings. The amount necessary for each twenty-four hours should be prepared at one time. It should be put in the requisite number of bottles, which should be stoppered with a plug of cotton batting and put through the pasteurizing process.

Care of the Bottles.

The bottles should be kept on ice, and warmed by standing them in hot water one at a time whenever it is necessary to feed from one. Each bottle should be thoroughly rinsed and cleaned immediately after using, and all should be boiled in a large pail together before being used again. The rubber nipples should be kept in a solution of boracic acid and be rinsed with clean water before using.

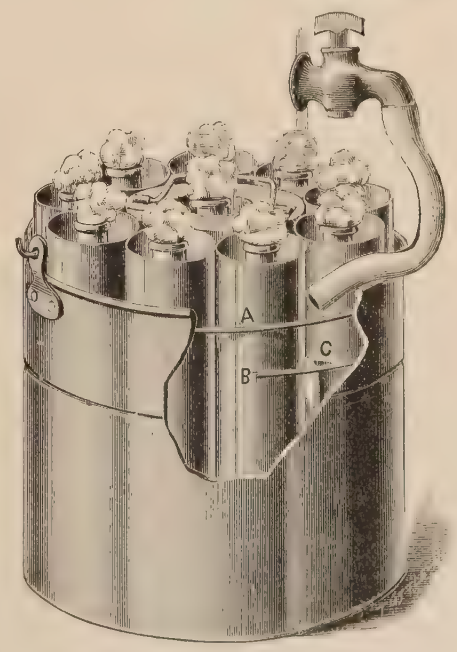


Fig. 5.—Freeman pasteurizer arranged for cooling the milk.

The pasteurizing process is done with a special pail and bottle rack known as the Freeman pasteurizer. The method is as follows: The pail is filled to the mark A with water and this is

brought to a boil; the bottles, filled with milk at the temperature of the room and each one surrounded in its own rack by cold water, is plunged into the boiling water. The cover is closed and the apparatus is removed from the fire and allowed to stand for half an hour on the floor (not on stone or iron). The rack of bottles is then raised, and, by running cold water into the pail, the milk is rapidly cooled and is ready for storing on the ice. Fig. 4 shows the pasteurizer just after the bottles of milk have been placed in the boiling water and before the pail is covered. Fig. 5 shows the apparatus arranged for cooling the milk.

Method of Pasteurization.

CHAPTER VIII.

PATHOLOGICAL CONDITIONS.

The diseases which are peculiar to the female sex are connected with the functional activity of the female sexual organs. The origin of these disorders is traceable most often to the act of childbearing, which may be considered to include the condition of pregnancy and that of lactation. The non-pregnant condition or period of menstrual activity is a secondary factor as a cause of disease.

Diseases of Pregnancy: Vomiting.

Many of the subjective signs of pregnancy may become developed to such an excessive degree that they will become a truly abnormal condition and may then be classed as a "disease." The most important of these is an excessive amount of vomiting. This may occur with so much persistency that the patient loses flesh and strength, becomes pale, develops a low fever and an extreme rapidity and feebleness of pulse, and may even grow so weak that life itself is threatened. If fatal, the symptoms are those of starvation—fainting attacks, muttering delirium, disturbances of sight and hearing, and finally unconsciousness and death. Such cases should never be allowed to go to the final stage, but radical measures should be adopted as soon as they become febrile and the pulse grows rapid and feeble; of course medical care will have been sought at an earlier period. The measures already suggested for the relief of the vomiting of pregnancy are as far as home treatment should be pushed; further measures depend on the peculiarities of individual cases, and, together with operative interference, are beyond the scope of this article.

The further derangements of the alimentary canal, constipation and diarrhœa, may develop to an excessive degree and threaten the termina-

tion of pregnancy. The diarrhœa of pregnancy is a pathological state in which the patient may grow thin and starve to an excessive degree similar to that caused by vomiting. The constipation must be counteracted by the use of mild laxatives and of enemata. The various preparations of buckthorn bark are good cathartics in these cases, but the enemata will give perhaps the best results. The diarrhœas must be controlled or the pregnancy be terminated; only careful medical treatment will accomplish either result.

Constipation and Diarrhœa.

The condition of poor nutrition which is so common in the first months of pregnancy may persist without any causal relation to the disturbances of alimentation just described. These patients become extremely pale and weak, suffer from shortness of breath and palpitation of the heart, also from attacks of fainting. They may have mild fever and the feet may swell up moderately. They may bleed from the nose, stomach, and bowels. Although ill, they do not grow especially thin. This condition is very serious and is often fatal. The only treatment is medical: to terminate the pregnancy artificially.

Pernicious Anæmia.

There is a certain form of inflammation of the kidneys which is characteristic of the pregnant condition, and which is a very serious complication when present. This disease is very insidious in its onset, but gives regularly certain signs in the urine before the serious symptoms develop. It is to anticipate such a complication that the urine of pregnant women is examined at regular intervals by their medical attendants. *This precaution should never be omitted, for the most dangerous complication of pregnancy may arise in appearance suddenly, but in reality after having given a neglected hint in the urine, and perhaps nowhere else.* As a rule, however, there are other symptoms: persistent frontal headache; pain in the upper part of the abdomen, with or without nausea and vomiting; double vision; dimness of vision; spots before the eyes, even blindness; swelling of the face and hands; also, but less characteristic, swelling of the feet and legs. The patient becomes short of breath even when at rest, and her mental condition changes—either to become irritable, or, on the contrary, somnolent. The most striking danger signs except the urine are the eye symptoms, the swelling of the face, and the condition of the nervous system. These precede more or less directly the dangerous condition due to kidney inflammation—the so-called eclampsia.

Kidney Disease.

The symptoms of eclampsia are an alternating condition of nervous irritability and nervous depression, a state of convulsion, and a state of unconsciousness. The convulsions of eclampsia are fairly characteristic; the patient first stiffens all her muscles and grows livid because of cessation of breathing, and then after

Eclampsia.

a short half minute begins to work the arms and legs and jaw in repeated jerks. This lasts five minutes or less, and the patient passes into an unconscious state which may last ten minutes or a number of hours. Even when of short duration the loss of consciousness is replaced by a state of stupor, which will be interrupted by fresh fits, by death, or by a gradual return to normal conditions.

The treatment for the bystanders should consist of restraining the patient only so much as will prevent her falling from the bed or otherwise injuring herself, and especially to protect the tongue by inserting a towel, cork, or piece of soft wood between the teeth, so that the tongue will not be bitten. The best treatment to shorten and control the fits is chloroform inhalation. This is, however, somewhat dangerous in unskilled hands and should be kept as a last resort. Of course such a patient needs immediate obstetric aid, and this is beyond the power of the nurse or friends to give.

The best treatment is the preventive treatment, and all patients who show any of the danger signals already mentioned should be put upon a diet which will give the kidneys and other food-transposing organs as little work as possible. Such a diet is an exclusive milk diet, and such a patient should take in each twenty-four hours as much of two quarts of milk as possible and should eat nothing else. Other measures should be modified to suit the condition of each particular case, but only under the direction of a physician.

Similar fits may occur from apoplexy or from epilepsy. If the former, the outlook is no better than in eclampsia; if the latter, there will be a history of previous attacks and no repetition of the fit, and the patient will return to her normal mental state within half an hour. Fits of very deceptive nature may be caused by hysteria, but both in hysteria and in epilepsy all the other signs, including those in the urine, are absent.

Local Disease in Pregnancy.

Inflammation of the parturient tract may occur during any pregnancy. The inflammations of the vagina are the most common. The symptoms are similar to those of inflammation at any time, and will often require treatment at the hands of a specialist. There are a number of abnormal conditions which are connected more directly with the fœtus itself which must be included among the diseases of pregnancy.

Death of the Fœtus.

The fœtus may die at any period of pregnancy. When this occurs the natural course of events is checked and the woman begins to feel weak and sick; she presents the signs of pregnancy, and then these signs suddenly cease developing and there is a partial attempt to begin lactation. These signs of pregnancy in part disappear and the remainder remain stationary. When such an event occurs the fœtus may remain indefinitely in

the uterus. The smaller the fœtus, the longer the period of time that must elapse before it is expelled.

Molar Pregnancy. In certain cases the membranes and afterbirth go on developing after the death of the fœtus, and the result is a formation of a so-called *mole*. This will be expelled in part as little grape-like vesicles, and lead to a diagnosis being possible.

Extra-uterine Pregnancy. Another accident to the impregnated ovum is that it begins to develop in the tube connecting the ovary with the uterus and not in the uterus itself. Such a condition can persist for a certain length of time with only the regular symptoms of pregnancy, but after a varying period of six weeks to three months the patient has attacks of pain and an irregular but fairly frequent brown discharge from the uterus. Such pains should attract and demand attention and lead to a careful examination by a physician. The treatment is strictly surgical.

Abortion. The fœtus may be expelled before the natural end of pregnancy. Such an event is styled an abortion in the early months, an immature labour in the middle months, and a premature labour in the latter months of pregnancy. The classical symptoms indicating that such an event is threatened are pain and hæmorrhage. The pain is similar to labour pain—intermittent, sharp, and referred to the lower abdomen and back. The hæmorrhage is more common in the earlier months and may be quite profuse; it is apt to be the earliest symptom. The later the event occurs the more nearly it resembles normal labour.

When a woman is threatened with an abortion she should keep perfectly quiet in bed and live on a restricted diet. She should avoid all excitement of visitors, exercise, and amusement. If the miscarriage is inevitable, the woman should take the same precautions about cleanliness and surgical antisepsis as is necessary after labour. She should also be content to keep quiet and in bed until the pelvic organs have regained their normal condition. The medical treatment of abortion is complicated and should be left to skilled hands.

Placenta Prævia. Another error in development of the fœtus is the formation of the afterbirth in the lower and not the upper segment of the uterus. In consequence of this the afterbirth grows in front of and not behind the fœtus, and the child can not be born until the placenta separates in whole or in part to make a passage for it. The separation will cause a certain amount of bleeding, which may be of alarming proportions. Hæmorrhage from the uterus during pregnancy may occur, as already noted, during the first few months and have no special significance. Such a flow of blood takes place at the regular intervals at which a normal menstruation would have occurred if pregnancy

had not supervened. It is of less amount and less duration than that of a regular period and gives no other symptoms than the loss of blood. Hæmorrhage in the early months of pregnancy is one of the principal symptoms of threatened abortion; in such cases the amount of blood is greater, it is of bright-red colour, and there is usually a discharge of clots. The flow may begin after some fall, and the time has no necessary relation to the interrupted monthly flow. The second principal symptom of abortion (pain) is soon added, and the case develops the characteristics of a true abortion; or the symptoms subside and abortion does not take place. After the third month of pregnancy there should be no hæmorrhage until after the birth of the child, except for a slight show when true labour begins. The condition known as placenta prævia, however, will cause a loss of blood, and in considerable and dangerous quantity, not only when labour begins but even before that period.

The usual course of these cases is that there will be a number of attacks of loss of blood occurring at irregular intervals between the fifth and eighth months of pregnancy. These attacks come on suddenly without previous warning and cease as quickly as they began. The amount of blood lost is usually small at first, but the final attack is apt to threaten life itself, because the amount of blood is so considerable and it is shed so rapidly.

The complication of placenta prævia is one of the most serious that can arise in the course of a pregnancy, and its treatment demands prompt action and accurate knowledge on the part of any practitioner. The lesson to be learned by the laity is to appreciate the importance of the seemingly inconsequential loss of blood of the early attack, and to summon professional aid before the serious accident occurs and the patient is beyond relief.

Pregnancy in Chronic Diseases.

It remains to speak of pregnancy occurring in women who are suffering from chronic diseases. The chronic diseases of the specially vital organs—the heart and lungs—are the ones of real import. All the organs of a pregnant woman are placed under an extra strain by the mere fact of pregnancy itself. If any organ is diseased to a degree to interfere with its functional activity it will do poorer work during pregnancy than before.

Tubercular and Pulmonary Disease.

Women who have an active tubercular process in any organ, especially if it be in the lungs, undergo a distinct increase of risk by becoming pregnant. Tubercular disease will become active after a pregnancy, even when it has been quiescent for a long time. The period just after confinement is the critical one, and prolonged lactation is a very serious menace to the life of the tubercular woman. The children of tubercular mothers inherit a weakened constitution and diminished power of resistance to the tubercular

germs; they may even be the subjects of tubercular disease at the time of their birth.

Heart Disease.

Organic heart disease results in a mechanical interference with the heart's action. Pregnancy, by throwing more work on this pump, will cause increased symptoms of mechanical interference, and all the symptoms of an uncompensated heart lesion will arise. The result to the woman will vary in proportion to the amount of disease present in the particular case. The milder cases will not be seriously disturbed; the serious ones may prove fatal. Each case must be judged for itself; but one can state the general rule that repeated pregnancies are to be avoided in women with organic disease of the heart. There is no bad result to the child born at term of such a mother, but pregnancy in such women is apt to end prematurely in abortion.

Kidney Disease.

Pregnancy occurring in a woman who has Bright's disease of the kidneys will cause an increase of the existing disease. This condition of the kidneys has also a tendency to terminate the pregnancy.

Uterine Disease.

Pre-existing disease of the uterus, whether inflammatory or of the nature of a displacement, has a very marked effect upon the normal termination of pregnancy. Repeated abortions, or the delivery of stillborn children, constitute the regular obstetric history of such patients.

Complications of Labour.

The various complications of labour and of the lying-in period demand prompt interference and skilful attention. It is beyond the scope of this article to detail all of these diseases and their operative treatment. It will suffice to point out the prominent symptoms, and to assist in this manner to a recognition of the conditions which demand absolutely a physician's aid.

Prolonged Labour.

The average duration of labour is for first labours, twenty-four hours; for subsequent labours, twelve hours. The greater part of this time is taken up by the period of dilatation. Delay may occur at any period, but is of more vital importance both to mother and to child when it occurs during the stage of expulsion. Besides the evidence of some obstruction given by the mere lapse of time, the woman will present certain symptoms: she will become weak and feverish, her pulse will grow rapid and feeble, her tongue dry, the pains change character, after a period of increased activity the uterus becomes tired, and the pains occur at long intervals and are weak. There are many causes for such delay, but they are beyond relief so far as an ordinary nurse is concerned.

If there is delay in the third stage and the placenta is not expelled within a reasonable time, no special harm can come to the woman, and she should be washed and put to bed to rest quietly. If the afterbirth is

not delivered at the end of twenty-four hours help should be secured. During the waiting period the uterus should be watched by placing a hand on the abdomen, and any tendency of this organ to enlarge or to soften should be controlled by friction and by pressure. The immediate danger of such relaxation is post-partum hæmorrhage.

Retained Placenta.

If the outlet of the genital canal has been torn it will heal under best conditions if it is sewed together by a surgeon. If the tear is small, or if no surgeon can be secured, it will require no special treatment other than extreme cleanliness and as little movement of the injured parts as may be. It may be wise to tie the patient's knees together for a week except when necessary to change her dressings. Such patients should be longer in getting up and about after confinement.

Laceration.

Hæmorrhage before labour is finished is a rare complication. It occurs more especially in the cases of placenta prævia already described. Hæmorrhage after labour, however, is more frequent, but is still an infrequent occurrence. If present, such a hæmorrhage may be a very serious and even fatal event.

Hæmorrhage.

The signs of threatened hæmorrhage are a relaxed condition of the uterus and a rapid pulse. The blood may collect in the dilating uterus or it may appear externally at once. The amount lost may be considerable—four, five, or more double handfuls of clots may be expelled in half as many minutes. A large double handful of clots is not an infrequent accompaniment of normal labour, but more than this will mean an excessive flow. If a woman is bleeding she will present the general signs of loss of blood. She becomes pale; she feels faint; she has thirst for water and for air; her pulse is rapid, weak, and irregular. In the worst cases she becomes restless and thrashes about her bed. With the first shock the body temperature falls, and subsequently rises again to a point above the normal.

The treatment is first to stop the flow, and second to support the woman's general strength. If hæmorrhage occurs, the uterus must be sought for and pressed upon through the abdominal wall. It must be held continuously in its contracted condition for at least an hour after the bleeding ceases, and must be closely watched for two hours longer. As soon as the uterus is found and held, hard pressure must be made to squeeze out the contained clots and the afterbirth, if it is not yet expelled. This pressure must be hard enough to be distinctly painful, and should be directed in such a way that the top of the uterus is pushed back and down. A piece of ice on the abdomen will help temporarily. Allowing the baby to nurse on the mother's breasts will induce uterine contraction. As to drugs, two will be of value—one dose of twenty drops of laudanum,

or an opium pill of one grain, or a morphine pill of one sixth of a grain, should be given to quiet the nervousness and restlessness and to steady the heart, and a teaspoonful of the fluid extract of ergot will help to cause a contraction of the uterus. A third drug which will not only not help, but which will be of a distinct disadvantage, is wine or whiskey or other form of alcohol. After the first flurry is over and the uterus is held firmly, a final local measure may be taken in the shape of a hot vaginal douche. This douche should be given only with strictest antiseptic precautions and with the douche bag and previously sterilized nozzle. The douche should be at least four quarts of boiled water, to each quart of which a tablespoonful of vinegar has been added, and should have a temperature of 110° Fahr. After the douche a fresh sheet may be spread doubled up under the patient's hips, but no special care should be taken for æsthetic cleanliness' sake. The patient needs quiet and rest above all else, and must be disturbed as little as possible. Finally, the foot of the bed may be raised and the patient's legs bandaged tightly from the toes up, to squeeze the blood out of the limbs into the body, where it will reach the brain and the heart and do the most good. The patient's thirst may be alleviated by water, cracked ice, and small amounts of milk, and other fluid food should be given at frequent intervals. After twelve hours she may have solid food if she can digest it without distress, and a plan of general tonic treatment and diet must be followed.

Other Complications of Labour.

The conditions already described as diseases of pregnancy may complicate labour as well as pregnancy. They may not develop until labour begins, or even until after labour is ended. The most serious of these are eclampsia and placenta prævia; they need no further notice here.

Complications of the Lying-in Period.

The whole list of complications of the lying-in period, except for those which, beginning before labour, continue in an active state afterward, may be summed up in the one word—*fever*. It has been stated already that the normal condition of a woman after labour is an afebrile one, and it should be a routine practice to take the patient's temperature every morning and evening. The thermometer will find here a very important use, for no other one symptom is a better indication that some trouble has arisen or is threatening. At the same time the degree of temperature is a very poor criterion of the severity of the illness in general or of the critical nature of the woman's present state. Care must be taken, therefore, to look for other signs of trouble, and not to infer a fatal issue because a woman's temperature rises suddenly to 104° or more. Neither must one go from the depths of despair to the ecstasy of hope with every rise and fall of the clinical thermometer. *There is no worse habit than the constant taking of a patient's temperature; it teases the patient and it worries the*

friends, and does no good whatever. The temperature should be taken at regular intervals, which should be every twelve hours in these patients.

Puerperal Fever.

Puerperal fever is a general term, and means that form of "blood poisoning" which arises from an infection of the parturient wounds, more especially of the wounded blood-vessels and tissue spaces at the site of the separated placenta. There are other causes of fever in the puerperal state, but this wound infection is the most serious, and in its severe forms one of the most dangerous, of all diseases.

Fever of Constipation.

It is the fate of most women to begin labour in a constipated condition, and this may have no special influence on the course of events to follow. In certain cases, however, a very marked febrile reaction will arise, due entirely to the constipation present. The fever of constipation usually is manifested by the third day, and is characterized by a more or less sudden rise of temperature, even by a chill; the pulse also becomes quickened, but not excessively so; thus, with a temperature of 103° Fahr., the pulse will often be below 90.

Besides the constipation there may be slight tenderness on the left side of the abdomen just above the groin, and a frontal headache, loss of appetite, and general feeling of illness will complete the clinical picture. The treatment is simple and consists of cathartics. Of these, perhaps the salines are the best. A simple enema of soapsuds and water may be necessary to start the action of the bowels.

Fever from the Breasts.

Another common cause of fever is found in the mammary glands. When regular nursing is begun the nipples are very apt to become bruised and even cracked, and an infection of the gland may easily take place through this wound. The glands, "caking" under the influence of beginning activity, become engorged with blood, swollen, painful, and tender. If an infection through such a nipple invades such a gland, a more or less intense inflammation will result. Inflammatory disease of the breasts may occur at any period of lactation, but it is most frequent during the first two weeks.

The symptoms of such an attack are a rather rapid rise of temperature and a quickened pulse-rate, a headache, and general body pains, especially in the back; there may be vomiting at the outset, the bowels may be constipated or normal, and the appetite is capricious.

The local signs are a hard, tender, painful, reddened swelling of one or both breasts. These signs may be diffused or localized in a certain part of the gland. The affected area is apt to be more or less triangular in shape, starting from the fissured nipple as an apex and spreading over

a widening surface to the periphery. This area is reddened in proportion to the amount of involvement of the skin itself.

If an abscess is to form there will be a limited area of inflammation, which finally becomes soft, and, if left alone, the skin breaks through in one or more places and there is a discharge of pus.

The course of these inflammations is either short, ending in resolution after forty-eight hours or so, or an abscess forms, and they run a tedious and long course to a cure. The short cases do not interfere with nursing; the longer and more severe ones check the flow of milk entirely, so far at least as the infected breast is concerned.

The treatment of the early stages is the same as already outlined for simple caking of the breasts, and consists of hot stupings repeated every three hours and continued for periods of ten minutes each time. In the intervals the breasts should be supported by a binder. The bowels should be freely evacuated by saline cathartics, and the patient should be put on a restricted diet for forty-eight hours. Nursing should be continued regularly, and any abrasion of the nipple should be cauterized once with a solution of nitrate of silver or with the solid drug (lunar caustic). Many incipient cases of inflammation can be checked by such treatment. If not so aborted, the treatment must be radically changed; and when pus is formed, surgical treatment, as for any abscess, is indicated. Nursing must then be stopped on the affected breast and the patient must be put on a generous diet.

Other Cases of Fever.

One form of treatment should be mentioned only to be condemned: the ordinary flaxseed poultice is a poor means of applying moist heat. As usually renewed, at intervals of two hours, the poultice soon loses its extra heat, and for the remaining time the patient keeps the poultice hot instead of the reverse being the fact. Any puerperal woman may be attacked by some intercurrent disease having no special reference to her condition. Bronchitis and tonsillitis are among the commoner kinds of inflammation which may arise. They need no special mention here.

Puerperal Sepsis.

The general symptoms of puerperal blood poisoning or septicæmia are those of any acute infectious disease, although the individual symptoms are fairly characteristic. The temperature runs a very variable course, at times high and at times low, reaching even the normal or below. These variations occur at irregular intervals and have no reference to the real course of the disease. The pulse is rapid and in severe cases weak and irregular. The pulse is the best guide to the patient's actual condition; a low temperature and weak pulse is a more critical state than the reverse condition of high temperature and strong pulse. The pulse is more rapid than the mere rise of temperature will suggest, and if the patient dies it is from failure of the heart's action.

The rapid elevations of temperature are very apt to be accompanied by chills, and the sudden falls in temperature by severe and exhausting sweatings. The onset of the disease is apt to be accompanied by nausea and vomiting, as are also the chills. At other times the patients will eat and digest solid food, although the appetite must often be tempted. The tongue becomes dry and coated. There is considerable headache and the patient is restless and sleepless. She is delirious, especially when asleep, but when awake is usually conscious even to the very end in fatal cases. The bowels are regularly constipated, but there may be diarrhœa. The urine is the dark-coloured and scanty urine characteristic of fever.

The local symptoms are also quite characteristic: the uterus, as felt through the abdomen, becomes soft and tender to pressure, the abdomen becomes swollen, and there may be general tenderness and abdominal pain. The lochia become at first scanty, even absent, but after a day are re-established and may present a foul odour. The secretion of milk is at first unchanged, but if the disease lasts any length of time the milk will be diminished often to a very marked amount. The patients lose flesh and strength and colour, and feel ill even from the very beginning.

Milk Fever.

The cases vary much in regard to the severity of the attack. They usually begin on the third day after labour, and may be a mere rise of temperature lasting twelve hours, or a fatal attack may result from the infection. The coincident occurrence of the onset of fever and the beginning of the secretion of milk led early observers to connect the two as cause and effect. This led to the naming of this condition "milk fever." No necessary connection exists between the two, and milk fever as such has disappeared from the lying-in chamber. Mild cases, and severe ones, too, of puerperal infection still occur, but the latter especially are much less common than formerly.

Milk Leg.

One especial form of puerperal infection must be mentioned apart; it is that form in which the inflammation attacks the large veins and extends from those of the pelvis to the veins of the leg. As a consequence of this the veins become plugged up by a blood clot and the blood can not return from the extremity. The leg, therefore, swells and remains large for some time. This is usually a severe form of the disease, and as a consequence the secretion of milk is diminished. The old idea was that the milk left the breast and settled in the leg, hence the old name "milk leg."

Treatment for Puerperal Infection.

The treatment of puerperal infection should be started early. The first indications are to eliminate other possible causes of temperature. The bowels should be freely moved by saline cathartics; a teaspoonful of Epsom salts every hour for six doses is usually efficient. The breasts should be treated as described above if there be the slightest evidence of trouble there. If after

thirty-six hours of this treatment the temperature is not normal or does not remain normal, there is probably an infective process at work, and skilful medical care is to be sought as early as possible.

Diet.

A word as to the diet of patients with this fever may be added. We are very apt to take our views on this subject from the essential treatment of our great endemic fever—typhoid fever. These cases are really very different. There are in septicæmia no ulcers in the intestine, which never fail in typhoid. The absolute rule for fluid diet does not apply in this case, and in fact these patients do best when taking all the solid food possible. They digest it readily and they need the strength. Alcohol is very beneficial to them. Whiskey is perhaps the best form for use in the United States.

Diseases of the Non-pregnant Woman.

The diseases of women may be classified as inflammations, displacements, deformities from injury, and tumours. These various forms of disease will be manifested by many similar symptoms, and the diagnosis between the many subdivisions is not always easy. It will suffice for the present purpose to detail the prominent symptoms of each group of cases and leave the differentiation of the special case to experts.

Symptomatology in General.

Disease of the female pelvic organs may cause any of the symptoms of disease in general. These signs of pathological process are called *general* because they affect the healthy action of the body as a whole, and are distinguished from the symptoms called *local*, which are referred particularly to the diseased portion of the body. These general symptoms present the picture either of an acute and more or less severe illness with all the manifestations of fever, or of a chronic cachexia with the loss of flesh and of strength, with anæmia and disturbance of the alimentary tract, and a condition of complete or incomplete invalidism. The local symptoms are manifested by varying amounts of pain and discomfort, by the development of unusual discharges from the genital tract, and by disturbances of the normal functions of these organs.

The chronic forms of disease are supposed to induce in these patients a special set of symptoms which can be classified neither as local nor as general in the usual acceptation of those terms. Of these peculiar or special symptoms mention may be made of certain kinds of pain of a reflex nature. The "left hypochondriac stitch" is a pain in the left side just below the breast; the "clavus" is a feeling as if a nail were being driven into the head; the mammary glands often ache and are the seat of reflex pains; and finally there is a headache in the posterior part of the head and neck which occurs frequently in these diseases. A feeling in the whole pelvis akin to pain—the so-called "bearing-down pain"—is a symptom of frequent occurrence in all pelvic disease. It is further pe-

culiar to these patients when the general nutrition suffers and they grow pale and anæmic that they develop nervous symptoms of an hysterical nature; they become selfish and exacting and morbidly dispirited; they may even become hypochondriacal. Acute inflammation of the external organs will present the symptoms of pain, swelling, redness, and local heat. There will be an increased discharge, purulent in character, and there may be painful and frequent efforts to pass water. Chronic disease of an inflammatory nature of the external tissues, and inflammation of the deeper organs, whether acute or chronic, will give similar but less pronounced symptoms. When the uterus is involved there may be a continuous dull pain, tenderness to pressure, local swelling, and a feeling of heat referred to the lower part of the abdomen in the middle line of the body. The menstrual function will be deranged and may be too frequent and too profuse. The patient may further develop, if married, a habit of aborting, or she may become sterile. Displacements of the uterus by which this organ is commonly tilted backward, or is pressed downward even to appear externally at the vulva, lead to a similar train of symptoms. In fact, both displacement and inflammation are frequently present in the same organ. The pain in these cases of malposition varies somewhat, and may be referred to the lateral part of the abdomen or low down on the side and above the groin. Such pain is constant, dull in character, and is increased by motion and exercise. It is commonest on the left side, but may be bilateral and of a dragging nature. The pain may be referred to the back, and then is situated over the lower part of the spine, usually over the pelvic spine or sacrum. The neighbouring organs will be functionally disturbed, and there will be frequent desire to empty the bladder and a difficulty in moving the bowels.

Lacerations of the genital tract which cause symptoms are due to severe injuries at the time of labour. The symptoms are due to the subsequent displacement of the pelvic organs, or to more serious injury resulting in the formation of communicating passages between the alimentary canal or the urinary tract and the genital passages.

Tumours.

The tumours of the female organs are either abdominal or pelvic. The symptoms of the former may be nothing more than an enlargement of the abdomen. The symptoms of pelvic tumours are pain caused by pressure on the nerves descending to the legs, which is therefore referred to the legs and not to the real seat of the disease, severe and persistent constipation, and finally a watery, sanious, and offensive discharge characteristic of the more dangerous forms. All tumours may cause a severe and prolonged flow of blood from the uterus. Tumours of these organs may be small and of no consequence—the so-called benign growths—or they may take on the most malignant character, proving in the end fatal, with every indication of a severe and wasting disease.

XI.

NERVOUS AND MENTAL DISEASES.

By FREDERICK PETERSON, M. D., Ph. D.

GENERAL CONSIDERATIONS.

The nervous system is so closely connected with every organ and tissue of the body, subserves so completely every function of the organism and of the mind as well, that care of and attention to it are of paramount importance. Undoubtedly, too, it is a nervous mechanism which lies at the basis of heredity. Hence the great tendency of nervous diseases in parents to entail upon the children shattered or unstable nervous systems.

Nervous System of Children.

Nervous disorders are more likely to affect the progeny than any other species of malady. It is therefore especially needful to guard the nervous system of the growing child against not only the evils of heredity, but against the acquisition of any nervous disorder that may prove disastrous in after-life. The brain and spinal cord and nerves of a child are more impressionable than any other portion of the organism. Upon them depends the storing up of all the impressions received from without and which constitute experience and all the higher functions which have to do with experience, such as memory, judgment, reason, will, and the emotions. A child may be looked upon as a bundle of nerves, easily stimulated by every external impression; easily overstimulated, too, so that its nervous system reacts quickly to overwork of body or brain and to any illness which may occur in it. It is remarkable how slight a bodily ailment or irritation is needed to induce delirium or convulsions in a child, or bad dreams and night terrors.

A nervous child, one predisposed by heredity or by a delicate organization to manifest nervous symptoms on the slightest provocation, should be taken in hand early and the family physician or a specialist be asked to regulate its daily life, lay out its hours of study and recreation and sleep, and prescribe the kind of diet best adapted to its needs. Only by such means can the evils incident to such a constitution be warded off.

The chief causes of mental disease, and of a great variety of nervous disorders also, are heredity and stress or strain of some kind. We shall turn our attention more particularly to the question of heredity.

HEREDITY.

Let us suppose that we can trace our lineage back to the time of William the Conqueror. The period of time considered is about twenty-five generations. As a person has two parents, four grandparents, eight great-grandparents, sixteen great-great-grandparents, and so on, one can readily estimate that at the time of William the Conqueror there were 33,554,432 ancestors actually taking part at that time in the formation of the descendant in existence at the present day. Adding to these, however, the intermediate forefathers between that date and to-day, the figures prove to be in round numbers about 67,000,000.

Potency of Blood.

Now, as blood, while not really ranking as a heredity carrier among physiologists, has from time immemorial expressed that idea, as evidenced by the common phrases "blue-blood," "blood will tell," etc., I carry my arithmetical process a little further by estimating that the descendant has 76,800 drops of blood in his body, so that had each ancestor contributed an equal share to its composition, that of his forbear in the time of William the Conqueror would have been a little over $\frac{1}{1000}$ of a drop.

But the truth is that our ancestors do not so divide their bequests that each has an equal representation in our physical and mental personality. Galton, for instance, assigns one quarter of the heritage of a child to each parent and one sixteenth to each of its grandparents, leaving one quarter to be divided in a constantly diminishing fractional ratio among his remoter ancestors. I have attempted to solve the mathematical problem of what infinitesimal fraction of heritage was left this descendant by one who fell in the battle of Hastings—about $\frac{1}{1,100,000,000,000,000,000}$.

Heredity Defined.

I have been assuming that the question of heredity is taken for granted, though I have often been asked if I believed in heredity; so I infer there may be some who have not a very definite idea of what is implied in the premises. I will say, therefore, that while the word is really a new one, and not to be found in some of the dictionaries, the fact of our inheriting attributes from our forefathers has been a matter of common belief in all ages. It is shown in such expressions as "like father, like son," "a chip of the old block," "good breeding," and so on. In Jeremiah it is said: "The fathers have eaten sour grapes, and the children's teeth are set on edge." Heredity is the theme of a number of Shakespeare's sonnets:

> "Thou art thy mother's glass, and she in thee
> Calls back the lovely April of her prime."

Heredity is one of those truths so transparent and so omnipresent that we accept it without thought of it and its far-reaching consequences.

Like begets like. In the acorn lies latent the ancestral oak, and as it bursts from the ground it grows to be the exact counterpart of its parent —bark and bole and branch and leaf.

From the willow springs the willow, and not the spruce. Man is not born a shapeless mass of protoplasm, developing by circumstance into some fantastic creature; but from his birth he has in him the elements which evolve the same muscles, bones, limbs, brain, eyes, hair—nay, the very features of his ancestors. To be sure we are more startled by the appearance of six fingers in the children of a six-fingered parent, because of its uncommonness; but is it not quite as marvellous and just as convincing an argument for heredity that they have any fingers at all, and especially that they have five, exactly the same number as their forefathers had? What I wish to express is, that it is not necessary to look for the presence of unusual inherited traits, though these undoubtedly serve to emphasize and call our attention to a fact so common that it otherwise might escape notice. It is a truth so constant and so plain that the word *reproduction*, when we stop to think of it, implies *heredity*—for what is reproduced is something that has been already produced. We start, then, on the self-evident principle that man, animal, and vegetable are reproduced each after its kind. Not only are the same physical characteristics inherited which give them their likeness to their ancestors, but those more ethereal qualities and characteristics, such as the spiritual and mental attributes of men and animals, the colours, taste, and perfume of trees and flowers.

The discussion going on in the scientific world between Darwin, Galton, Weissmann, and their followers is not so much as to the truth of heredity as it is concerning the theories of heredity, as to what are heredity-carriers, as to how and in what proportion ancestral qualities are bequeathed to us, as to how we have been modified and improved through the lapse of ages, as to whether acquired traits are inherited in great degree or not.

Racial and Individual Characteristics.

Each man is made up of certain numbers of bones, muscles, nerves, blood-vessels and organs, arranged in a certain form, which belong to him as a man and distinguish his race from others. These are racial characteristics which we all possess. Besides these physical qualities we have other attributes, such as instincts, emotions, perceptions, intellect, will, ethical qualities, which may be summed up in the general term "human nature." These are also racial characteristics, and are possessed by every ordinary man. Our anatomies, then, and our human nature are the qualities given us by the race, possessed in common by us all, and upon this racial

foundation are built the qualities which distinguish us from others—our individual characteristics—as a rule comparatively slight variations in physical structure and mental qualities, for few are distinguished by any extraordinary physical or mental attributes; when we are, it is expressed by excess of one kind or another, and we become Samsons, monstrosities, geniuses, or idiots.

Rudimentary Organs.

In going carefully over the human structure, however, we find among our racial characteristics certain eccentricities, so to speak, which are shared by us all; unnecessary appendages that certainly do not belong to us, for we have no use for them, and yet for countless ages we have been passing them down by inheritance from one to the other. I allude to rudimentary organs, such as, for instance, the three muscles which are attached to our ears, the mammary glands in the male, and the appendix vermiformis connected with the large intestine, which gives us so much trouble by being the site of appendicitis. Of what possible use are they? Innumerable other animals and many plants possess similarly curious heritages. The ostrich has no need for wings, nor the unborn whale for teeth, nor the mountain tadpoles, which are never near the water, for gills (*Salamandra atra*). All these rudimentary organs are doubtless records of ancient states when they were of service. They are reminiscent of conditions in the infancy of the race. I cite them here because of their having been retained solely through the wonderful force of heredity. They probably had no utility even as recently as a hundred thousand years ago. Think of the virility of those ancestors who have left this lasting impress upon us, and of the extraordinary power of the heredity carriers which, in giving us our bodies and our human nature, have not forgotten these little testimonials of kinship bequeathed us by our antique relatives.

Hereditary Impulses.

Doubtless there are vestiges in our minds, too, of immemorial instincts and aspirations which the complexity of our mental processes makes it difficult to discover; for as the growth and development of our bodies as well as our minds depends upon the brain and spinal cord and all the delicate filaments which radiate from them to every tissue, so the nervous system plays the most important part in the influences which have to do with heredity. The nervous co-ordinations must be rearranged by strong stimuli in order to be reproduced by the heredity impulse. This is why traits acquired by us in our individual lifetimes are not apt to be inherited by our descendants. If a person loses an arm, his children are not deprived of that useful member, for the nervous mechanism of development which has for ages produced arms in their proper places and which is fixed in the powerful hereditary impulse of the race has not been changed. So in the breed of dogs whose tails have been cut off for countless generations, not

one is born without a tail, because the nervous co-ordinations governing the evolution of the tail bear down with all the hereditary force of the race since its first beginning when the tail existed, though the animal was legless, to keep it in existence. Probably if we could in some way reach this nervous mechanism which is responsible for the evolution of the tail we might prevent, or at least modify its development. Just as the physical organization depends upon the nervous system, so too does the whole mental organization. Both mental and bodily characteristics are hereditary.

The Abuse of Alcohol.

Wherever the nervous system is profoundly disarranged—as, for instance, in a number of nervous diseases—there may be a change in the nature of the heredity impulse. Such profound derangement of the nervous system may be produced, for instance, by poisons. As a striking and common instance let us take alcohol. This poison, when taken to excess, vitiates the blood and causes organic diseases of many viscera, but is particularly noteworthy for its terrible effects upon the brain. We have all heard of or met with cases of alcoholic gout and the drink craze and alcoholic insanity, and these conditions are well known to be hereditary. But there are other hereditary states, not perhaps so familiar, induced by alcoholic indulgence. *The children of an inebriate parent are not only apt to be feeble physically and mentally, but, worse than this, idiocy and epilepsy are frequently due to this ancestral vice.* In a report on idiocy in the State of Massachusetts one half of the idiots in an institution were the progeny of habitual drunkards. I have under my charge in New York city some five hundred idiots, on Randall's Island, and while it is difficult to obtain accurate histories in the majority of cases, I am convinced that the proportion due to drink in the parents is very large. Dr. Howe, of Massachusetts, tells of a drunkard who was the parent of seven idiots. Dr. Kerr mentions a family of six children. The two oldest were perfectly healthy; after their birth the father became a habitual drunkard, and the remaining four children were born during this period. One was feeble-minded and the other three were idiots.

Alcoholic Indulgence and Epilepsy.

While alcoholic indulgence frequently causes epilepsy in its victims, and this epilepsy may become hereditary, it is rather common to find epilepsy in the children of drunkards who may not themselves have been epileptic. It is one of the frequent legacies left by the inebriate to his children. If not idiotic, or epileptic, or inebriate, the children of drunkards frequently inherit shattered and unstable nervous systems, rendering them hysterical, neurasthenic, possibly criminal, and an easy prey to insanity or other nervous disorders. Nor is it the first generation only that may suffer for the parents' excesses. Such vicious heredity has been known to manifest itself for at least three generations.

In passing to another form of profound disarrangement of nervous coordinations sufficient to affect the hereditary impulse, let us look at insanity. *The two great factors in the production of all cases of insanity are heredity and strain.* Since most people do not become insane, it is evident that their nervous systems are sufficiently stable to withstand the ordinary incidents in the struggle for existence. There are of course stresses of such severity that any nervous organization, no matter how great its stability, may be upset; but the individual of average stability is not apt to be affected by any of the ordinary vicissitudes of human life. We may be sure, therefore, that when insanity develops it is due to some hereditary weakness in the nervous organization. It is not necessarily a direct legacy from insane parents; what is left to the child is a fragile nervous constitution, and this may have descended from ancestors back of the immediate generation. The evidence of this inherited fragility of the nervous mechanism may present itself as insanity, or it may be epilepsy, or it may be feeble-mindedness, or it may be criminal tendencies, or it may be simply nervousness, hysteria, or certain kinds of headaches, or possibly only eccentricity. All of these disorders are more or less interchangeable, and are merely proofs of an unstable nervous organization. Thus hysterical or eccentric parents may have insane children, and epileptic parents criminal descendants, and so on. Epilepsy and insanity are closely related, and their interchange is perhaps more frequently observed than that of the other conditions mentioned. The tendency to an unstable nervous structure may lie dormant for a generation or two, appearing in the grandchildren or great-grandchildren. This phenomenon is called latency, or reversion, also atavism, and is frequently observed in connection with various kinds of heritage in animals of all kinds. In human beings it is noted in the nervous diseases already mentioned, and other disorders, such as the hæmorrhagic diathesis, multiple fingers, and the like.

Insanity.

Now as to the nature of criminal heredity. You have probably all heard of the Jukes family. A Dutchman born about 1730 gave origin to a progeny numbering in all perhaps twelve hundred members. Out of this number Mr. Dugdale calculated by careful study that there were two hundred and eighty adult paupers, one hundred and forty criminals, sixty habitual thieves, seven murderers, and fifty courtesans, and he calculated the loss they caused to the State in seventy-five years to be one and a quarter million dollars, without "taking into account the entailment of pauperism and crime of the survivors in succeeding generations, and the incurable diseases, idiocy, and insanity growing out of their debauchery and reaching further than we can calculate."

Criminal Heredity.

In certain researches among criminals in prisons it has been found that so close a relationship exists between hereditary nervous disorders and

crime that more than forty per cent. of the prisoners had a history of insanity, epilepsy, idiocy, and other nervous diseases existing in their families.

In England it has been determined that "the ratio of insane criminals to sane criminals is thirty-four times as great as the ratio of lunatics to the whole population of England."

Fortunately for us, there is a dominance of the racial hereditary impulse, a force bearing down upon us from antiquity and tending to bring us back to the normal type, from which the weakness or sins of our immediate forefathers may have tended to deflect us. So there is a natural inclination for the unstable nervous system to disappear. Otherwise we might all of us in time become insane.

Prepotency.

A very interesting feature of heredity is what is known as prepotency. The attributes of our ancestors, bequeathed to us, if unlike, struggle for supremacy; if alike, they are emphasized. Sometimes there is a blending of qualities—as, for example, in the colour of the skin. The child of a black and a white parent is half white and half black, a mulatto; of a mulatto and a white, a quadroon; of a quadroon and a white, an octaroon. Sometimes a strong characteristic has preponderance or prepotency, like the Bourbon nose, which persisted for at least four generations. So too with mental attributes; some may assume the mastery over others, and conditions like insanity may become prepotent in a family, in which cases marriages should naturally be so regulated that the racial hereditary impulse may come to the rescue.

The chief points in the laws of heredity that may be summed up here are as follows:

Laws of Heredity.

Offspring tend to inherit every attribute of both parents, and since the parents have inherited from the grandparents *ad infinitum*, there are innumerable faint or latent attributes from remote ancestors which tend to appear in the offspring. When circumstances are favourable, these latent attributes may become more strongly marked, may become prepotent, so to speak, and the child may show a reversion to the type of a great grandfather or some other ancestor. A child is a new combination of two lines of ancestral traits, and in him there is a struggle for survival among these different traits.

Still another law is, that characteristics which have appeared in a parent at a certain time of life tend to appear in the child at the same period. This is shown in the epochs of normal growth, the periods of puberty, adolescence, change of life, and senility. It is also shown in the frequent tendency of offspring with insane inheritance to break down at the same period of life as did the parent or grandparent. A particularly interesting example is the form of insanity known as paranoia, a strongly marked hereditary form, in which there is a regular cycle or sequence of

events. First there is eccentricity and morbid shyness during childhood; a melancholy and hypochondriacal condition up to the age of thirty; then a development of delusions of persecution; and following this, indeed growing from this, delusions of grandeur, of being a prophet, king, reformer, or saviour of mankind. We have examples in the cases of Joan of Arc, John Brown, Mohammed, John of Leyden, and others too numerous to mention here.

Another very interesting law is that a certain degree of dissimilarity between parents seems to be necessary for the production of healthy offspring, and that when parents have a very similar constitution, or an exceedingly dissimilar constitution, the effect is deteriorating. As an example of similarity of constitution, take the case of cousins. It frequently occurs that cousins inherit characteristics that resemble each other remarkably, traits prepotent in the family, and in case of their marriage the children will be degenerate, feeble-minded, idiotic, or insane. This has been noted so often that it is a matter of popular knowledge. At the same time there are countless examples of the marriage of cousins without such unfortunate results, for the simple reason that it is more common for cousins to be dissimilar in their constitutions than similar. The marriage of cousins is only disastrous where some such attribute as instability of nervous organization is prepotent in the family.

Traits, Acquired or Congenital.

The question whether a trait is acquired or congenital is sometimes difficult to solve. For example, a drunken mother bears children who also become drunkards, imbeciles, epileptics, or lunatics. There is no denial of the fact of heredity here, nor can there be a denial of the fact that this is an acquired trait on the part of the mother. At the same time we must remember that the mother, saturated with alcohol, saturates her children before they are born with this poison, thus shattering their nervous system before they have yet seen the light. The nervous diseases of her grandchildren are not inherited disorders *acquired* by their parents, but the inheritance of their *congenital* defects. After all, the important point to keep in mind is that such traits or modifications of character in our ancestors are inherited by us, and we need not quibble over the minor question as to whether they are acquired or not.

Psychic Heredity.

In an earlier part of this argument I stated that not only physical, but also mental and moral attributes are among the legacies bequeathed to us by our forefathers. It may not be amiss here to dwell a little upon some of the features of psychic heredity—as, for instance, upon hereditary genius. Galton has written a volume upon this subject which is a mine of interesting information, dealing, as it does, with three hundred families, containing among them one thousand eminent men, of whom four hundred and fifteen were illus-

trious examples of genius. They consist of judges, statesmen, commanders, literary men, scientific men, poets, artists, and divines. He finds that exactly one half of illustrious men have one or more eminent relatives. The large number of eminent descendants is due to the marriage of illustrious men with women who were above mediocrity; for while it is a popular opinion that men of genius marry women below mediocrity, such proves by examination not to be the case. Another popular idea—that great men have remarkable mothers—proves also not to be a fact, though such men are undoubtedly greatly indebted to maternal influence as well as to paternal. The sons of gifted men are much more precocious than their parents, and are apt to be ruined in health by overwork, while the daughters are apt not to marry, either because accustomed to a higher moral and intellectual tone in the family circle, or because of cold, shy, odd, or blue-stocking manners that render them often unattractive to men. For such reasons illustrious men do not leave as many gifted descendants as they otherwise would. Galton proves that it would be possible to produce a highly gifted race of men by judicious marriages in consecutive generations. A prevalent opinion that men of genius are physically feeble, puny, and stunted in growth is found not to be true. On the contrary, in strength and stature and massiveness they rank highest, though there are and have been a few exceptions. In this volume of Galton the illustrious men selected are chiefly English, or such as are well known to Englishmen. He avoided foreigners through fear of errors; but he advises any reader to select a dozen names of eminent men in any profession and of any nationality, and to study the characteristics of their kindred. He will be astonished at the results.

Individuality.

From all that I have stated concerning the inheritance of physical organization, of mental characteristics, of moral and criminal attributes, of disease and defects, and of genius, it would almost seem as if we had nothing original in us, as if we were mere compounds of attributes bequeathed to us and for which we are not responsible, and which we, in our turn, pass on to our descendants. Our only individuality lies in the fact that the mixture and development of attributes given us varies in each person. Some blend and are emphasized, become prepotent; others, dissimilar in nature, struggle with each other for mastery. The two packets of physical and mental qualities handed down to us by our father and mother, and containing, besides the individuality of our parents, all the characteristics of the race, might be roughly compared to two complex chemical substances mixed together, which unite chemically to form a new substance. The new compound has qualities peculiar to itself, and yet in it are attributes of the ingredients which entered into its composition. Or we might compare heredity to a kaleidoscope which contains a number of bits of coloured glass repre-

senting ancestral bequests. Each turn or shake of the kaleidoscope gives us a new individuality, wonderful and beautiful in its details, some more so than others, and yet the materials of which the marvel is composed are always the same.

STRESS OR STRAIN.

Causation of Nervous and Mental Diseases.

While a hereditary instability of the nervous system is undoubtedly the chief factor in the causation of insanity, and also in the ætiology of many nervous diseases, such as hysteria, neurasthenia, epilepsy, and the like, yet another important factor is stress of one kind or another. Perhaps every individual has a certain amount of instability of his nervous system, so that some strain, if sufficiently severe and prolonged, may upset the normal balance, and it is evident that the degree of stress necessary to disarrange the normal mental or nervous equilibrium must vary with the resistance of the individual subjected to the stress. Fortunately, the majority of people have nervous systems of fair stability, and do not readily give in to the vicissitudes of life. The stresses or strains which are well known to often excite nervous or mental diseases are briefly as follows: Blows upon the head; organic brain diseases such as meningitis; apoplexy; tumours; various acute or chronic diseases in any part of the body affecting the general health and nutrition; changes in the circulation of the blood (congestion or anæmia), and particularly the vitiating of the blood by toxic diseases or by poisons (specific disease, specific fevers, such as smallpox, diphtheria, scarlet fever, typhoid, etc., and in the line of poisons may be mentioned opium, alcohol, cocaine, coal gas, carbonic-acid gas, carbon bisulphide, hasheesh, tobacco, coffee, tea, etc.); finally, the so-called moral strains, such as worry, anxiety, grief, fear, and so on.

Predisposing Physiological Conditions.

There are physiological conditions of the organism, too, which in a certain way render the individual liable to be more easily affected by the combined or separate action of heredity and strain; conditions of great activity or change at the different periods of life, which put the system into a state to be readily influenced by adverse circumstances. To this category belong the active changes incident to the growth of a child—the period of puberty and the era of adolescence. Here also belong the so-called internal "commotions" brought about by pregnancy, childbirth, and lactation, and by the change of life. The period of degeneration or senility, when retrogressive changes in the tissues are active, is furthermore a condition in which hereditary taint and stress, more or less severe, may induce nervous or mental disease.

We shall now give in alphabetical order the names and definitions of the more common diseases of the nervous system and of the mind, with some brief account of their symptoms and their treatment.

NERVOUS DISEASES.

Abscess of the Brain.—A collection of pus may take place in the brain at any age of life. The cause is nearly always some septic material that finds its way into the brain. Usually the poison comes from disease of the ear, but injuries to the scalp or skull, and diseases of the nose or orbit of the eye, may lead to the formation of abscess in the brain. Sometimes it is from general specific poisons in the blood, such as those of scarlet fever, typhoid fever, and the like. Injuries to the skull are more common as a cause in childhood than any other. Sometimes a month, or even a year or two, elapses after an injury to the head before the development of the abscess.

The symptoms are very different in different cases, owing to the varying position of the formation in the brain. Headache, chilliness or fever, sleepiness, vomiting, delirium, stupor, convulsions, dizziness, or paralysis, and so on, are among the manifestations met with in varying degree and frequency. The diagnosis of its presence and position must be made by an expert in such disorders, and the treatment in suitable cases is altogether surgical. An operation is made for the removal of the collected pus if the specialist and surgeon consider it advisable. Prevention is, as in all diseases, the chief point to bear in mind. Early and strict attention to injuries to the head and to diseases of the ear, orbit of the eye, and nose is of paramount importance.

Alcoholic Inebriety.—There is no class of cases that comes under the care of the physician that presents greater difficulties in the way of treatment than that of sufferers from alcoholic inebriety. To the practitioner are brought such as are in the stage of alcoholic neurasthenia, such as present symptoms of acuter alcoholic conditions, such as have delirium tremens, such as are insane from the abuse of this poison, and such as exhibit actual organic lesions of the nervous system, like alcoholic neuritis and alcoholic pseudo-ataxia. Patients may come under his observation in any of these states, or in the intervals between paroxysmal outbreaks of the drink habit, when they may present no particular symptoms. He may be required to treat the *nervous* conditions of alcoholic excess, and there may be lesions of other than nervous viscera demanding his attention, like gastric disorder and cirrhosis, and their sequelæ. Thus there are states for immediate attention, and there is the habit itself exacting his best judgment and skill in the way of eradication and prophylaxis. There is therefore a wide field for therapeutic applications of great variety. Leaving out the treatment of the chronic organic conditions, such as lesions of the peripheral nervous system and viscera, our advice is generally sought to relieve the excitement or nervous exhaustion of a recent

debauch, and to formulate some plan for combating the tendency to recurrence.

The best treatment of acute alcoholism of any form may be briefly summarized, but no treatment should be undertaken without the physician's advice and supervision:

1. Cut off all alcohol, and confine to bed.
2. Blue pill at night, followed by saline cathartic.
3. Hot wet pack for sleeplessness.
4. Hypodermic injection of nitrate of strychnine, gr. $\frac{1}{60}$ to $\frac{1}{32}$.
5. Water, milk, koumiss, broths, soup, meat juice, raw eggs, arrowroot, juicy fruits, and the like, when there is gastric disturbance.

This is the outline, in short, of a kind of treatment adapted to all cases of acute alcoholism, though bromide and chloral, or duboisine, are indicated in a certain number of instances.

In chronic alcoholism, which manifests itself most commonly as a form of neurasthenia, the following should be the ordinary routine treatment:

1. Cut off alcohol.
2. Hot wet pack for insomnia.
3. Disturbances of the alimentary canal to be met by aperients and dyspeptic remedies (rhubarb and soda, hydrochloric acid, and the like). The diet should be milk, eggs, and vegetable foods, meats rarely.
4. Strychnine again the main agent to restore nerve tone; best given hypodermatically, but may be given by mouth in combination with quinine, or in fluid extract of cinchona (gr. $\frac{1}{60}$ to dr. j), or in infusion of gentian.

Having now briefly gone over what I consider to be the best methods of meeting immediate conditions apparent in any case of inebriety brought to the physician for advice and treatment, the more important question arises how to rid the patient of the habit—how to cure the disease of inebriety. This is a most complex question, and one that has for many decades commanded the attention of all men—laymen, lawyers, physicians, and charlatans. Either the desire for alcohol must be got rid of, or the alcohol itself must be made unattainable. To eradicate the desire, appeal has been made to the enfeebled will of the victim by lectures, pledges, hypnotic suggestion, religious influences, and the like, sometimes with success; and drugs have been lauded by physicians, and secret nostrums by quacks, to accomplish the same end, sometimes also with success, though not so much through the merit of being an antidote to the desire for drink as by virtue of the support by faith or suggestion given the weak will of the patient.

On the other hand, to make alcohol unattainable, the law has been invoked to regulate liquor-selling in general, to prevent its sale to drunk-

ards, to imprison *habitués*, or to commit them to inebriate institutions for a definite length of time. All of these means have been successful in individual instances. But no drug has been found that is always equal to destroying the desire, and the laws are inadequate as regards regulation of the liquor traffic and the isolation of the drunkard from his ruling demon. Sequestration in a penitentiary is limited by the law, and the writ of *habeas corpus* has been the evil genius of special institutions for inebriates. Many are committed to insane asylums, but after a few weeks of rest and treatment the debauch is recovered from, and, not being insane, the asylum has no longer the power to detain them. So they come and go several times in the year with the regularity of the seasons. The rich try the inebriates' homes and the poor are condemned to the penitentiaries. They are "repeaters." Think of being brought up for the two hundred and forty-sixth time before a police court for drunkenness—yet this has happened, and the defendant was a woman!

In the cases that generally present themselves to us, commitment is as a rule the last resort. We try moral suasion, occasionally hypnotism, and we make usually half-hearted attempts at treatment by drugs. We send them on long sea voyages on sailing vessels containing no liquor; we try the watchful care of a companion or nurse. Sometimes these means are effectual, generally not. The despairing friends after a time resort to the advertising quacks. Their remedies are no more efficient than those already in our hand, but it must be confessed that they often take more pains with each individual case than we do. Some of the advertised inebriety cures seem to be not only swindles, but cruel and criminal swindles. Several years ago the chemist of the Massachusetts State Board of Health analyzed some of these so-called cures for inebriety, in order to ascertain how much alcohol they contained. The analyses published were as follows: *

Scotch oats essence	contained	35	per cent.	alcohol.
The "best" tonic	"	7·65	"	"	"
Carter's physical extract	"	22	"	"	"
Hoofland's German tonic	"	29·3	"	"	"
Hop tonic	"	7	"	"	"
Howe's Arabian tonic	"	13·2	"	"	"
Jackson's golden seal tonic	"	19·6	"	"	"
Liebig Company's cocoa beef tonic	"	23·2	"	"	"
Mensman's peptonized beef tonic	"	16·5	"	"	"
Parker's tonic	"	41·6	"	"	"
Schenck's seaweed tonic	"	19·5	"	"	"

The so-called gold cure of Keeley, upon analysis, was found to contain no gold at all, but in each teaspoonful about one thirty-second of a grain of muriate of ammonia, one sixteenth of a grain of aloin, and forty-

* *Medical Register*, July, 1888.

five minims of compound tincture of cinchona. His hypodermic injection was ascertained to be composed of sulphate of strychnine, atropine, and boracic acid. The Keeley cure, while it has been doubtless effectual in curing many cases of inebriety, has not made use of any drug not long ago tried by physicians all over the world. One of the advantages of this much-lauded method is undoubtedly the effects of repeated suggestion. We have not been in the habit of paying that particular attention to inebriates that is necessary; we are too prone to dismiss such a case with a mere prescription and some good advice. I may be pardoned for citing an instance of the value of continuous attention. A young man of wealth was apparently a confirmed inebriate. Everything had been done for him on ordinary lines that could be done—drugs, moral influences, change of scene and occupation, the dismissal of his boon companions. I found a teetotal sailing vessel and sent him to the South Seas and China, a nine months' voyage without a drink. He came back robust, hopeful, took to drink at once, and had incipient delirium tremens in a few days at a hotel. Before sending him to an inebriate institution, for which I had made arrangements, I decided to give him one more trial. An occupation was found for him in a down-town office, and he was put upon the strychnine treatment, but was made to report daily at my office at a certain hour. This he did for a year. He has not tasted a drop for three years, and is married, prosperous, and happy. I believe the continued attention and suggestion of the daily visits to my office were the remedial agents in his case, the strychnine merely acting as a prop to his nervous system as he was passing through the ordeal of deprivation of his wonted stimulant. Since then I have had several other cases. Hypnotism I have tried once or twice with considerable success. The treatment I should outline for the removal of the habit, and which I have found often very efficacious, is briefly as follows:

1. The hypodermic injection of nitrate of strychnine in the doses already given, at least twice daily, more frequently if possible, and always by the physician himself. The moral influence and personality of the physician are of the greatest importance. By this frequent contact of physician and patient the effort and attention of the inebriate are kept continually at their highest pitch.

2. A diet of milk, eggs, and vegetable foods should be enforced, meats being allowed but once daily.

3. Regular occupation, regular hours, and the avoidance of the society of fast companions must be insisted upon.

4. There is a certain class of patients to whom a substitute for a dram of liquor is at times imperative; when the desire comes on it must be satisfied. The substitute must be immediately at hand. With some of these a combination of strychnine and fluid extract of cinchona (gr. $\frac{1}{60}$ to dr. j)

taken with a glass of water works very well. It is not always convenient, however, to carry a bottle in the pocket, so I am at times in the habit of prescribing powders composed of from twenty to forty grains of red cinchona bark, half a grain of capsicum, and three grains of powdered nux vomica, to be taken with a glass of water when required.

As I have already stated, the Keeley cure depends largely upon suggestion for its results. It has had many successes, but, of course, also many failures, which latter are seldom published to the world. I have had four Keeley failures under observation. One is now insane with complications of hepatic cirrhosis and chronic gastric catarrh, and their sequelæ. He will not live long. The second is also insane. The third is under treatment with me. The fourth has been apparently cured in a sanatorium for inebriates, and has had no liquor for over a year.

There is a multitude of cases in which no treatment yet devised avails to check the alcoholic propensity, and in these the only alternative is to put them out of the reach of alcohol. How difficult this is to accomplish is well known to us all. Commitment for three to six months, which is the longest period permissible in all the institutions I know of in this country, is merely temporizing. It should be commitment for one to two years, or even more. It is a fact that the nervous system and the heart and other organs do not recover their normal equilibrium in less than two years after prolonged alcoholism, and sometimes even four to six years are needed to re-establish healthy functions. Recently a step in the right direction has been taken by an institution in this city. For some five years I have been the attending physician of the House of Mercy, which is in charge of the Sisters of St. Mary, of the Episcopal Church. When they removed from the foot of West Eighty-sixth Street to new buildings at Inwood I induced them to form a department for inebriate women in the new quarters. The Sisters became interested in the project, and the trustees have had a bill passed by the New York Legislature which is quite unique in this country. This department in the House of Mercy is called the St. Saviour's Sanatorium. It is empowered to receive women inebriates either by voluntary or legal commitment. In the latter case two physicians are required to make out certificates, and upon these a judge commits the patient for a year. Before the expiration of the year she may be recommitted, if it is deemed expedient, for another year. Hence patients may be detained here for two years. This feature of extended commitment for a long period marks a new epoch in the history of such establishments. St. Saviour's Sanatorium is beautifully situated on the Hudson River in the upper part of New York city. The rooms and parlors are cheerful, pleasant, and inviting. Out-of-door exercise and drives, as well as indoor employment, and the companionship of the Sisters and lady visitors, are features of the treatment. Thus far there are

accommodations for but sixteen patients, and these are selected from the refined and cultured classes, the institution being too small for the accommodation of all classes of female inebriates, even if it were possible or desirable to mingle people occupying different moral and intellectual stations in life.

There is also in this city a somewhat similar institution for male inebriates, the New York Christian Home, where religious influence is the chief remedial agent. I am convinced of the great usefulness of such influence in many cases.

One of the great drawbacks to all homes of this kind is the *tedium vitæ* from which patients are apt to suffer; there is not sufficient employment or recreation; the routine and monotony become irksome.

If I were to suggest an ideal means of dealing with inebriates, it would be the establishment of a little world in which alcohol had no place, but in which life with its various occupations, domestic arrangements, and amusements went on exactly the same. It would in fact be a colonization scheme, such as has proved so valuable in the case of epileptics and of the insane, only much more extensive and much more feasible. The problem involved is merely the exclusion of alcohol from all part in the colony's affairs. It is true that this could not be accomplished in any region open to ordinary traffic, travel, and communication; even a Chinese wall built around such a colony would not protect it from the invasion of its enemy; it would find some means to percolate through. But I can imagine some Temperance Island so far removed from the mainland as not to be accessible to small boats, with only one harbor, five to ten or more miles in diameter, amenable to the laws of the United States, the property of a corporation of practical philanthropists, where all boats and baggage and merchandise would be thoroughly quarantined against the introduction of alcohol, as if it were a *Comma bacillus* or the microbe of the Black Death. Here would be villages and industries, manufactures and arts, the commoners and the gentry, living in business prosperity and domestic happiness. Thither the drunkard would repair with his family, and, obtaining a position, support himself and them and lead a useful life, as if such a thing as inebriety never existed. A majority of inebriates would immigrate there of their own accord, but certain ones would need commitment by law for three years. Such commitment, however, would be no hardship, for the rights of voting, of citizenship, the solace of society, the pleasure of following one's trade or calling, of earning a livelihood, and of living with one's family would make existence not only tolerable but blessed. The realization of such a project is not an "iridescent dream." It is quite within the bounds of feasibility. A small additional tax upon spirits and spirit venders would be sufficient to acquire some Nantucket and consecrate it to this purpose.

Alcoholic Paralysis is a form of inflammation of the nerves which gives rise to wasting and palsy in the legs and arms. It is a multiple neuritis, and is not uncommon in individuals who take large quantities of alcohol for long periods of time. They become bedridden, and often the mind becomes weakened in a peculiar way; but abstention from alcohol almost always results in recovery. The paralysis has to be treated by a physician with lotions, massage, and electricity.

Anæmia of the Brain signifies a want of blood, and consequently malnutrition of the brain. Any disease which induces lack of blood in the whole organism may affect the circulation in the brain. The symptoms are faintness, headaches, dizziness, confusion of mind, nausea, sleepiness or wakefulness, mental depression, spots before the eyes, and ringing or roaring in the ears. Sometimes all of these symptoms, sometimes only a few, are present. The treatment is directed to improving the quality of the blood and increasing the supply to the head, but should only be undertaken by a physician.

Anæmia of the Spinal Cord is a lack of blood and want of proper nutrition of this great bundle of tracts and fibres connecting the brain with the periphery of the body. The symptoms vary very much. Among them are pain in the back, weakness in the legs, headaches, dizziness, trembling, and general weakness of the whole body.

Anæsthesia is a word employed to define a loss of sensation of the skin in some part of the body. There is anæsthesia of the skin when the prick of a needle or touch of a feather are not felt, or heat and cold readily distinguished in a part. Anæsthesia is merely a symptom of the cutting off of communication between the conscious brain and the area or part affected. The disease may be in the brain or spinal cord, or in the nerves going from the skin. Sometimes there is no actual organic disease to account for it, and it is termed functional or hysterical. The hysterical form is generally easily cured by the physician by means of electricity or hypnotism.

Aphasia is a term applied to various forms of loss of speech. There are certain parts or centres in the brain which control speech. There is a spot where words heard are remembered; another where words seen are remembered; another where the movements necessary to articulation are remembered; and another where the movements needed in writing words are remembered. There are also two or three other centres connected with speech, but the complexity of the arrangements underlying speech is so great that special study would be required to unravel and comprehend them. These centres are joined together by tracts or strands of fibres, so that they can act harmoniously. It is evident that an injury to or destruction of any one of these centres, or of any of the connecting fibres (such as often occurs from hæmorrhage into the brain, stoppage of

an artery going to the part, or from tumours), would produce a disturbance of speech, some peculiar form of aphasia. The patient might not understand words heard (word-deafness), or words seen (word-blindness), or might not be able to talk because of injury to the word-muscle centre (motor aphasia), or to write (agraphia). Thus one form of aphasia may be present, but the other speech functions go on as before. The study, understanding, and treatment of such affections must be left to the specialist in nervous and mental diseases.

Apoplexy.—By apoplexy we mean a sudden shock to the brain from hæmorrhage into it or by plugging up of a cerebral artery, inducing paralysis. Usually there is loss of consciousness with the attack, occasionally convulsions. Before the attack there may be some warning in the way of headache, dizziness, numbness of a hand and foot on one side, and full feelings in the head. As a rule, the shock is quite unexpected and the patient loses consciousness and falls. His face becomes flushed, the pulse hard and slow, the breathing deep, noisy, and laboured. Often the paralysis is evident at once in the face or limbs. The paralysis varies with the part of the brain affected, so that with apoplexy we may have half of the body paralyzed (hemiplegia), or the speech centres may be affected (aphasia), or sensory centres may be implicated (anæsthesia), and so on. Until the physician arrives and orders treatment in accordance with the kind of disorder of the brain found by him, all that can be done is to put the patient in bed and keep him perfectly quiet in a horizontal position. Ice may be applied to the head in most cases in a rubber ice bag, and hot-water bottles, carefully wrapped in towels, to the extremities. If it is long until the physician arrives, the bowels may be relieved by an injection or by giving the patient a cathartic (one drop of croton oil). It is needless to say that no liquor should be given. As there are two kinds of apoplexy (one due to hæmorrhage and one to the stopping up of a blood-vessel), it is plain that the methods of treatment will be radically different, and nothing more should be done until the physician arrives.

Four fifths of all cases of apoplexy occur after the age of forty, and with each decade of increase in age there is an increase of the apoplectic tendency.

Atrophy means wasting. The word may be used in connection with wasting of any tissue, but usually atrophy of muscles is more strikingly apparent than any other form. There is a disease known as *progressive muscular atrophy*, in which the muscles gradually waste away first in one extremity, then in the others and over the trunk. The "living skeletons" of our museums are always examples of this disease. It is really a disorder of the spinal cord, of the centres in the spinal cord which govern the nutrition of the muscles. A local atrophy of the muscles may occur from overuse (as in sewing, writing, hammering, etc., incessantly),

or from injury to a nerve; but these local atrophies are nearly always curable. We use massage, lotions, inunctions, and electricity in treatment, but a physician should be depended upon to determine the nature and cause of the wasting and to outline the proper treatment.

Basedow's Disease.—See *Exophthalmic Goître.*

Bell's Palsy is a paralysis of the facial nerve supplying the muscles of the face. There is one to each half of the face. In this paralysis the forehead can not be wrinkled on one side, the eye can not be shut, the cheek can not be moved; the patient can not whistle or blow the cheeks full of air because one side of the mouth is paralyzed. It is a common form of paralysis, due generally to lying with the face in a draught, but sometimes to ear disease, for the facial nerve lies close to the middle ear in emerging from the skull. The physician can generally tell on examination whether there will be recovery, and how soon; most of such cases recover ultimately.

Birth Palsy.—There are two kinds of paralysis occurring at the time of birth which are spoken of as birth palsies. One is caused by pressure on a nerve, such as a large one going to the arm, so that one arm hangs useless when the child is born. Usually recovery takes place under treatment directed by the physician. The other kind of birth palsy is far more serious, since it is apt to be brought about by hæmorrhage in the brain while the head of the infant is undergoing pressure during delivery. This hæmorrhage usually paralyzes one half of the body, or both lower extremities, or even occasionally all four limbs. The damage to the brain is usually so great that there is a greater or less degree of mental impairment in addition to the paralysis, so that the child grows up an imbecile or idiot; it is also apt to have epilepsy. Very little can be done for these cases except to ameliorate the epilepsy and to place such cases in special schools where they can be taught to walk, talk, care for themselves, and even to learn some occupation, to such an extent that they will not be altogether useless. It is surprising how extraordinary may be the mental and physical progress made by these seemingly hopeless cases by pedagogic treatment.

Caisson Disease is a paralysis of the legs due to disorder of the spinal cord brought on in workers in caissons or diving bells by the sudden return from condensed air to the normal atmosphere.

Catalepsy is a trance state with a peculiar rigidity of the body, often called waxy flexibility. The limbs will remain for long periods of time in any position in which they are placed. Catalepsy may be brought about by hypnotism, but usually occurs in hysterical cases as one of the multiform manifestations of hysteria. The sleeping individuals often described in newspapers are cases of hysterical catalepsy. The state may last from hours to years. Recovery is usually spontaneous and immediate.

Convulsions, or spasms, are violent contractions of the muscles, nearly always accompanied by loss of consciousness. Convulsions are not a disease, but merely a symptom of a great variety of morbid conditions. While they occur at all ages, they are so common in infancy and childhood that it has been well said that *convulsions in children correspond with delirium in adults.* One author said that there are some children who have convulsions as easily as some people have delirium or dreams.

They are then the symptom of a strong irritation of the central nervous system, for the seat of the discharge of energy is, of course, in the brain. The imperfect development of the growing nervous system of infants and children renders them especially prone to be affected. A child is a bundle of nerves and nerve-centres and reflexes in a state of great activity, acquiring a great number of new impressions, and governing the processes of growth and repair. Yet true it is that the healthy child rarely suffers from convulsions. It is the child with the hereditary taint and unstable nervous system that falls an easy victim to convulsions. There is an inherited convulsive tendency. Some families are more predisposed to infantile convulsions than others. Drunkenness and epilepsy in parents give rise to the convulsive tendency in children.

Aside from heredity there are innumerable exciting causes, such as rickets, anæmia, toxic states of the blood (from the infectious fevers); and then there are the reflex causes, such as teething, disturbed digestion, worms. They occur too in many organic diseases of the brain, like apoplexy, tumours, and so on.

The repetition of convulsions at regular periodic intervals constitutes epilepsy.

Death may occur during convulsions, owing to disturbance of the centres for the breathing and the heart in the brain. Sometimes convulsions induce such engorgement of blood in the brain that hæmorrhage takes place, and it is found that there is some form of paralysis which persists after the return of consciousness.

Naturally, treatment, to be efficacious, must be directed to the cause, but only a physician can discover the one of twenty or more exciting causes for convulsions.

The home treatment should be briefly as follows: It may be laid down as a safe rule in all cases to give a warm—*not a hot*—bath of 96° to 97°. The patient may be immersed in this bath for a half hour or more. Perfect quiet should be insured. When the physician comes, he will administer chloroform by inhalation, or chloral by enema, or some other efficacious remedy; but this should on no account be undertaken without medical direction.

Cramp is a painful, steady contraction in a single muscle or group of muscles, generally due to fatigue in the parts affected. Most people are

familiar with a cramp in the foot, leg, or jaw. It is not uncommon as a result of overuse in certain professions or callings. Among the most common of these are writer's cramp, pianist's cramp, compositor's cramp, cigar maker's cramp, telegrapher's cramp, and so on. In such individuals the cramp comes on whenever the fatigued muscles are to be employed in the old way, and the disorder becomes chronic and, unless cured, disables them altogether as far as their customary occupation is concerned. These cramps are curable by following carefully certain directions as to particular exercises, massage, and electric treatment.

Epilepsy is a chronic disorder of the brain, characterized by periodical attacks of loss of consciousness and generally convulsions. It has often been popularly called "the falling sickness." The convulsions may last a few minutes or longer. They may take place many times a day, or once in a week, a month, a year, or more. Severe attacks are called by physicians *grand mal.* Mild attacks, where the patient merely loses consciousness and does not fall or have a convulsion, are known as *petit mal.* Sometimes instead of a convulsion a patient may have an outburst of mental excitement with violent and destructive tendencies—a condition known as *psychic epilepsy.*

Like ordinary convulsions, epilepsy is not a disease in itself, but a symptom of a great variety of morbid conditions. We call it epilepsy where convulsions become habitual.

The causes that lead to the discharges in the higher convulsive centres are, as has been said, various. Epilepsy may be due to injury to the head, to organic disease, such as old meningeal hæmorrhage (as in infantile cerebral palsies), to tumours, and the like. It may be reflex in its nature, although these are extremely rare cases. Reflex epilepsy may arise from genital or gastro-intestinal irritation, from nasal or dental difficulties, from old scars implicating nerve filaments, and, in some very exceptional cases, from eye strain. Then there are toxic blood states which at times induce periodical convulsive attacks, such as auto-intoxication from absorption of poisonous substances from the intestinal tract. It is possible, as research progresses more satisfactorily, that a toxic condition of the blood may in time be found to be the cause in the majority of cases of epilepsy. At any rate, recent investigations seem to point in that direction. It is thus seen that the physician's first duty to his patient is to examine him very carefully for traumatic causes, for eye, ear, nose, and mouth defects, for old scars on the body, for genital or gastro-intestinal irritations, for the vestiges of old infantile monoplegias or hemiplegias, for symptoms of intestinal auto-intoxication, and for evidences of intracranial tumour, meningitis, and so on. Now, I think it is a fact that, as a rule, in the majority of epileptics, none of these evident causes may be discovered. The cases in which a definite origin may be traced

are in the minority, but, finding such indications, the treatment must, of course, be directed to remedying them. In a few clear cases of head injury surgical operation is advisable, but even in such cases it must be conceded that the results are seldom particularly favourable or satisfactory. Operations do, however, often prevent attacks for months or longer, or diminish their frequency, whether the operation consists of trephining, circumcision, or tampering with eye muscles, or what not.

So, too, in cases suspected to be of autotoxic origin. Treatment directed to diminishing sepsis in the intestinal canal has proved, as I and others have often found, of considerable value in lessening the frequency of attacks, though I can not say any are thereby cured. In most cases our treatment must be of two kinds—one, general, directed to improving the moral and physical condition of the patient, and the other special, directed rather empirically to diminishing and abating convulsive seizures.

By moral treatment I mean the placing of the epileptic in surroundings where he will not feel a sense of isolation from the rest of mankind; where he may occupy himself in some useful calling, especially out of doors; where his mental attributes may be developed by proper schooling; and where social intercourse and entertainment may tend to alleviate much of the suffering which the neglect of his family and healthier associates in the busy world of men induces. Residence in an agricultural colony or village community, such as the newly established Craig Colony in New York State, is, then, one of the primary requisites to moral treatment.

In regard to the patient's general physical health, each particular physical defect or disorder demands its appropriate remedial agent. But many cases require general upbuilding and tonic remedies for conditions of impaired nutrition, anæmia, and nervous depression.

Hydrotherapy is of considerable service in epilepsy. Cold shower baths and cold sponge baths daily are beneficial. The shower baths should be rainlike in character—that is, not too forcible.

In many cases a morning and evening bath (the half bath) proves very serviceable. The half bath is taken in a tub only half filled with water, and when taken should be accompanied by energetic rubbing of the patient by an attendant. This bath lasts five minutes, and the temperature should not be under 50° and not over 70° Fahr.

Where there is evidence of hyperæmia and increased blood pressure to the head, the cold cap is useful.

While these are the general indications for hydrotherapy, certain measures are often of use at the time of seizures. During a fit, or during a *status epilepticus*, it will be observed that there are one or two vascular conditions present: either the face is pale and there are signs of brain anæmia, and in this case warm wet compresses should be applied to the

head and genitals, accompanied by friction of the trunk upward, the body being placed with head low and arms uplifted; or there is turgescence of vessels in the head, the face is red, the carotids beat strongly, and under such conditions a contrary procedure is indicated—cold compresses to the head, neck, and genitals, strong wet beating of the feet, with a high position of the head.

When it comes to the special treatment of the attacks themselves by means of drugs, and which I have called a rather empirical method, we have a few agents which are of distinct service; but the medical treatment should be left wholly to the family physician, and indeed no form of treatment should be undertaken at home without his advice, unless it should be the simplest of home methods.

Exophthalmic Goître, also known as Basedow's disease and Graves's disease, is a disorder characterized by a swelling of the thyroid gland in front of the throat (goître), by bulging of the eyes, and by rapid beating and palpitation of the heart. The disease is readily recognised by the tumour at the throat and the protrusion of the eyes. It is supposed to be due to an excessive or perverted secretion of the thyroid gland. Constant medical attention is requisite in these cases, many of which are curable by means of drugs directed to diminishing the frequency of the heartbeats, by means of rest in bed, by the proper use of electricity, or by removing a portion of the diseased thyroid gland.

Facial Paralysis.—See *Bell's Palsy.*

Graves's Disease.—See *Exophthalmic Goître.*

Headache, or cephalalgia, is the most common of nervous conditions, and over a third of the population are affected with it. Fully one half of womankind suffers headache at one time or another. It is not a disease, but a symptom of a great variety of morbid conditions. These conditions may be grouped as follows:

1. Blood states: anæmia or hyperæmia of the brain; gout, rheumatism, diabetes, uræmia; infectious fevers and malaria; lead, alcohol, tobacco.

2. Nervous conditions: hysteria, neurasthenia, epilepsy.

3. Reflex causes: from disorders of the eye, nose, throat, ear, stomach, or sexual organs.

4. Actual disease of the brain: meningitis, tumours, disease of the blood-vessels or skull bones.

Undoubtedly the most common causes of headache are anæmia and dyspepsia. Headaches are sometimes in front of the head, sometimes at the top, behind, or at the side. The last is often termed migraine (shortened from hemicrania). The pain varies in different persons and according to the cause. It may be throbbing, dull, constrictive, burning, boring, or sharp. It may last but a few hours, or may last sometimes for weeks and months. Dizziness, nausea, and vomiting sometimes accompany head-

ache. The pain is really situated in one of the membranes of the brain which is supplied with sensitive nerves from the fifth pair (or trigeminal nerve).

In the treatment it is absolutely necessary that the physician should study each case carefully, in order to discover the one of many possible causes. Otherwise treatment would be altogether empirical. *Too much can not be said against a patient's taking drugs indiscriminately for relief.* Much harm can thus be done in the use, for instance, of such powerful agents as antipyrine, caffeine, phenacetine, morphine, and the like. The regulation of the bowels, careful attention to diet, the application of local agents like ice, or hot water, or tight bandages, and the use of hot or cold foot baths, are the home methods of treatment which are simplest and safest. Beyond this the patient should not be permitted to go unadvised.

Hydrocephalus is a condition popularly known as "water on the brain." There is an accumulation of fluid in the cavities of the brain, and in infants and children the head gradually increases in size until it assumes sometimes enormous proportions. The exact cause of the disease is not known. In some cases the process ceases of its own accord, but in most cases it progresses, and all treatment seems to be more or less futile.

Hyperæmia of the Brain means an increase of the blood in the brain. The chief symptoms are a sense of fulness, pulsation and pressure in the head, headache, dizziness, mental confusion, sleeplessness, and ringing in the ears. They are increased by stooping over or lying down. The treatment indicated is to lessen the amount of blood in the head by medicines given to that end and by the application of ice to the head, cups to the back of the neck, and quiet and rest.

Hyperæmia of the Spinal Cord is an excess of blood in that organ. The symptoms are heaviness and weight in the legs, numbness, creeping sensations, pain in the legs and back, and twitching of the muscles. Much the same indications for treatment exist here as in the analogous cerebral state.

Hyperæsthesia signifies an increased sensitiveness. Thus we speak of hyperæsthesia of the auditory nerve when a person is oversensitive to sound, of the optic nerve when oversensitive to light, of the skin nerve when slight touching is painful. Hyperæsthesia is sometimes due to disease of the nervous system, but is often hysterical.

Hypnotism is a trance-like state, a mesmeric condition, a morbid mental state artificially induced, and characterized by diminution or loss of consciousness, by a loss of will-power, by a concentrating of the mind upon some one idea that may be suggested, and by a peculiar readiness to yield and obey commands or suggestions.

One method of inducing hypnotism is to have the subject fix his eyes

for some five or ten minutes upon some bright object held a few inches from the eyes and slightly above them, so that there is some strain in the effort to see the object. It is a species of fascination. Another method is termed suggestion. The hypnotist places the subject in an easy-chair, or upon a sofa in a comfortable position, and then talks to him in a positive and confident way (makes suggestions, so to speak), telling him he will be sleepy in a few minutes, that his breathing is growing deeper, that he is drowsy, that his eyes are closing, and so on. After some minutes (five to ten or fifteen) the subject really sleeps.

After being once hypnotized the subject falls into the state more readily. It is believed that the Buddhist trance states, and the trances of spiritualists and clairvoyants, when not mere trickery, are hypnotic conditions induced by themselves (auto-hypnotism, auto-suggestion) through fixing the attention upon some object or idea.

Fully a fifth or a fourth of the persons upon whom it is tried may be hypnotized. Children are especially susceptible.

Hypnotism is injurious to the mind, and no one should ever permit himself to be subjected to it, or allow of its trial or exhibition for mere amusement. In some very rare cases it is of some value as a remedial agent, but should only be employed by or under the direction of a physician. A vast amount of harm has been done by its indiscriminate use.

Hysteria is a real disease. It is not an organic disease, but a functional one, and the seat of the disorder is in the gray matter of the cortex of the brain, though what actual change takes place there is altogether unknown. Most people are familiar with the word hysteria, and know how it is applied to the most various symptoms. It is characterized by emotional states, such as excessive laughing and crying, impulsive acts, great nervousness, headaches, pains in various parts of the body, a choking or constricted sensation in the throat (globus), and in severe cases often by great mental excitement, delirium, convulsive attacks (hystero-epilepsy), loss of voice, vision, or hearing, by paralysis or stiffening of the limbs, or by cataleptic states. The loss of voice (aphonia), the blindness or deafness, and the paralyses and contractures of hysterical subjects are not organic, and therefore not serious conditions. Nearly always these are quickly and easily cured by any strong appeal to the mind or any sudden surprise, such as may be exercised by the physician in giving electricity or hypnotism. It is these hysterical cases that are so miraculously cured at religious shrines, by faith healers, and the like.

Seventy-five per cent., or perhaps more, of all cases of hysteria have a history of hereditary taint, of hysteria, insanity, alcoholism, or other morbid state in the parents or grandparents. Four times as many women as men suffer from it. Hysteria in men is not so uncommon as popularly supposed.

As regards the treatment of hysteria, the chief means should be moral. It is absolutely necessary to isolate such a case from the sympathizing friends and relatives. This is the first indication. In addition to the new environment, the patient's life should be so regulated that occupation of some kind, adapted to the needs of the case, may be carried on. The patient's mind should be interested, and thus led back to a normal balance. For hysterical children the discipline of well-managed schools is of great value.

Physicians find, as regards other treatment, that great benefit is derived from a proper use of hydrotherapy (water cure), electricity, certain kinds of exercise, massage, and a few valuable medicinal agents in the way of nervines, tonics, sedatives, and so on. Treatment should not be undertaken without the advice of a physician.

Infantile Spinal Paralysis is a disease that comes on suddenly in infants or children with fever, vomiting, diarrhœa, and sometimes convulsions. The most striking feature, however, is a widespread paralysis. All of the limbs seem helpless. In a few days the paralysis begins to disappear, and as a rule most of it passes away, leaving a group of muscles in one limb permanently paralyzed and wasted. Usually it is one leg below the knee that is paralyzed. Sometimes it is one arm, and in rare instances two or more limbs may remain permanently affected. The cause is probably an infectious one, a germ which, entering the blood, produces its effects chiefly upon the part of the spinal cord which regulates the nutrition and motion of the muscles. There are a few instances of epidemics of this disease on record. The disorder is usually termed *poliomyelitis* by physicians, a word which means inflammation of the gray matter of the spinal cord. *Infantile cerebral paralysis* must not be confounded with this spinal form of paralysis. They are totally different in many ways. In the cerebral form, the brain being the part affected, we are apt to have impairment of the mind and epilepsy in conjunction with paralysis of one or both sides of the body. (See *Birth Palsy.*) In the spinal form of paralysis the mind is never affected and there is no epilepsy. Both at the outset and after the acute stage has passed off the physician only can advise the proper treatment. The permanently paralyzed limb will need months or even years of attention, partly to stimulate recovery of the muscles by massage, electricity, and baths, and partly to relieve any deformity by the wearing of specially devised braces or apparatus.

Insomnia, or sleeplessness, or wakefulness, is a condition due to a great many causes. It is a prominent symptom in beginning insanity and during the course of insanity. It is common in nervous exhaustion or neurasthenia. It is found frequently in hysterical individuals. Sometimes it is hereditary and habitual through life. It is often due to or-

ganic diseases, such as heart and kidney disease, or blood states, like gout or rheumatism. One can not go without sleep for longer than three weeks, and such sleeplessness as that is found only in the insane. When people say they have not slept for weeks, they mean that they have had many sleepless nights during that time.

It is quite clear that in the treatment of insomnia one must first ascertain what cause exists for it out of the multitude of possible causes. Then this cause must be treated. *The taking of drugs of any kind to induce sleep should be the last resort.* Foremost among the methods for bringing about natural sleep, and nearly always successful, is that of hydrotherapy.

The prolonged warm whole bath may be used. Temperature, 70° to 90° Fahr. Duration, half an hour to two hours. When of long duration the patient may be suspended in a hammock made of a sheet.

As a general hypnotic agent, however, applicable to all forms of insomnia, the hot wet pack stands foremost. It is applied in this way: A blanket nine by nine feet is spread upon the patient's bed, and upon this a sheet, wrung out dry after dipping in hot water, is laid. The patient lies down upon this, and the sheet is at once evenly arranged about and pressed around his whole body with the exception of the head, after which the blanket is also immediately likewise closely adjusted to every part of the patient's body. Other dry blankets may now be added as seems necessary. The patient remains in this an hour or longer—all night if asleep. See *Nursing the Sick*, Figs. 18, 19, and 20.

When simple measures of this kind that are harmless (except in some organic diseases of the brain or heart), and may be easily carried out at home, prove unavailing, as will rarely be the case, then the physician must be appealed to to prescribe some safe sleep-producing drug, and if he is a wise physician he will guard against two dangers—first, the acquisition of a habit by his patient; second, the ill effects of the drug itself upon the system. Fortunately we have nowadays hypnotics which may be taken without fear of acquiring a habit, and a few which may be taken for some time without hurtful results to the organism.

Lead Poisoning.—While lead poisoning is most common in workers in white lead (painters), it is not uncommon for people having nothing to do with lead, apparently, to be poisoned to a certain degree by it. Lead nearly always enters the system through the stomach with water or food. Painters get it upon their food from their unclean hands. Water stagnant in lead pipes becomes contaminated. Some of the cheaper kitchen utensils often contain lead. Lead is found in certain face powders and hair dyes. Lead shot is sometimes used for washing out bottles. Hence there are various sources whence one may be unsuspectedly poisoned. Headaches and constipation, followed later by attacks of colic, then by

paralysis of the arms (dropped wrist), then by dropped foot, delirium, convulsions, are the symptoms of lead poisoning.

Persons, such as painters, who are known to be exposed to poisoning by lead should use the greatest care that the lead does not get into the alimentary canal. With this end in view, meals should never be eaten in the workshop, and the greatest possible cleanliness of the hands before eating should be observed; also dilute sulphuric-acid lemonade is a valuable drink for workers in lead. When the system is once poisoned, and symptoms of lead intoxication are evident, the treatment consists in elimination of the lead and relief of the individual symptoms. For the first purpose diuretics, laxatives, and some preparation of sulphuric acid are the most efficacious remedies. The individual symptoms should be treated according to their nature—viz., strychnine and electricity for the paralysis, laxatives for constipation, sedatives and analgesics for the cerebral symptoms.

Lockjaw.—See *Tetanus*, in the article on *Surgical Injuries and Surgical Diseases*, Chapter II.

Locomotor Ataxia.—This comparatively common and distressing affection is a disease of the posterior columns of the spinal cord, of the dura mater, a membrane which surrounds the spinal cord, and of the posterior nerve roots.

It occurs much more commonly in men than in women, and generally commences in persons between the ages of thirty and forty-five years. In a large proportion of cases it has specific disease as a predecessor.

The onset of the disease is gradual, and very commonly the first symptom noted by the patient is his inability properly to control the movements of his legs and feet. It is not a paralysis, but is what is called a loss of co-ordinating power, so that while the strength in the legs remains as good as ever, the control of them is to a greater or less degree lost. This may first be noticed by the patient on going downstairs, he finding difficulty in estimating the distances of the steps, or he may be troubled by an uncertainty in his gait when walking in the dark. Such a condition is called ataxia, and thus the disease gets its name. The symptom, although not always present in the earliest stages, is seldom slow in appearing, and is regularly progressive until, in its most advanced form, the patient is bedridden simply from an inability properly to direct his muscles. In many instances, however, locomotion with the aid of a cane is possible for many years. This uncertainty of movement more rarely involves the hands as well.

The pains of locomotor ataxia are very severe, and generally are an early symptom. They occur most frequently in the legs and are of a stabbing or boring character. They are often called lightning pains from

the frequency with which they dart, like lightning, from one end of the limb to the other.

Among the other symptoms which are very numerous may be mentioned numbness and tingling of the hands and feet, drooping of one eyelid, squint, seeing double, blindness, non-reaction of the pupil to light while it responds to accommodation, loss of knee-jerk, inability to stand erect with eyes closed, sudden attacks of vomiting or of shortness of breath. Although the patient may ultimately be confined to bed, bed-sores rarely develop. Constipation is the rule, and there may be retention of urine or loss of bladder control. If the former occurs, there will pretty surely result an inflammation of the bladder, which very commonly is the immediate cause of death. While the suffering and discomfort caused by this disease are very great, the general health remains good, and the patient, if his life is a sedentary one, may continue at his work almost indefinitely. Cure is almost impossible, and when cures are reported it is easier for any one who understands the nature of the change in the spinal cord to believe that the diagnosis was incorrect than that destroyed nervous tissue has been repaired.

The course of the disease may extend over twenty or thirty years, and in fact the disease itself can hardly be said to destroy life. But its victims are necessarily more exposed than healthy individuals to intercurrent diseases, which are the direct causes of death.

Treatment is chiefly symptomatic. The treatment by suspension, proposed in Russia and for a time largely practised in France and other countries, has been almost entirely abandoned. Mercury and iodide of potassium are usually prescribed on theoretical grounds, and occasionally appear to be of service. The pains are difficult to control, as, on account of the long course of the disease, morphine, which relieves them, must be employed with only the greatest caution and reluctance. Phenacetine is often efficacious in diminishing the intensity of the pains. Cold baths are to be avoided, but warm baths occasionally do no harm and refresh the patient.

In case the urine must be drawn by catheter, it is imperative that the minutest antiseptic cleanliness of the instrument be observed. (See *Nursing the Sick*, Chapter VIII, Fig. 15.) Other symptoms as they occur are to be treated on the lines of general therapeutics.

Meningitis.—The meninges are two membranes by which the brain is enveloped; inflammation of one or both of them is called meningitis. Of this there may be many forms. They are all popularly called in the acute forms brain fever. Among the acute varieties may be mentioned—

1. *Cerebro-spinal meningitis* is an acute infectious disease, involving the membranes of the brain and spinal cord, which occurs in epidemics or sporadically. Children are attacked by preference. There are gener-

ally two or three days of malaise before the symptoms become alarming. Then develop severe headache, pain, tenderness, and rigidity of muscles at the back of the neck, delirium, fever, sensitiveness of the eyes to light, and very commonly a rash, from which the disease is sometimes called "spotted fever." There may be also inflammation with interference of function of the cranial nerves or those of the limbs. As the disease progresses, restlessness and delirium are replaced by somnolence or unconsciousness. The average duration of the disease is from ten days to two weeks, and its mortality, while variable, is always high. There is no specific treatment.

2. *Simple meningitis* is a result of septic material acting on the pia mater. The most common source of infection is from a diseased ear, although the poison may come from any infective focus in the body. The symptoms commence rather abruptly, and consist of intense headache, pain in the back of the neck, fever and delirium alternating with unconsciousness. The respiration is irregular and the pulse apt to be slow. There also may be, as in all brain diseases, paralysis from pressure on or destruction of the nerves. The course of the disease is from ten days to three weeks, and the prognosis is very grave. The treatment, once the disease has declared itself, is purely symptomatic.

3. *Tubercular meningitis* is a tubercular disease of a cerebral membrane, just as consumption is a tubercular disease of the lungs. Both owe their existence to the action of the tubercle bacillus. In its common form the disease occurs in young children, and its development is dependent on the entrance into the body of the tubercle bacillus—viz., through the air-passages, or in the food (milk), or by the extension to the pia mater of tubercular processes elsewhere in the body. The prodromal symptoms, which generally continue for some little time, consist in a change in the child's disposition, lack of interest in its play, peevishness, headache, and loss of appetite. These warnings finally merge into the disease itself, which regularly ends in death. There are headache, delirium, fever, and vomiting, with local paralysis, and in the later stages coma. The breathing is very irregular, and the pulse, slow at first, becomes rapid toward the end of the disease.

Mesmerism.—See *Hypnotism*.

Migraine.—See *Headache*.

Muscular Atrophy.—See *Atrophy*.

Myelitis is an inflammation of the substance of the spinal cord. There are several varieties, of which transverse myelitis only, acute and chronic, will be considered here.

Acute transverse myelitis occurs most frequently in young men, and may be a result of exposure, of injuries to the spinal column, of the

infectious diseases, or of any process which allows septic organisms to enter the spinal cord.

The spinal cord is involved not for its whole length, but in small foci, which involve the cord in its entire circumference. The constitutional symptoms are slight; the symptoms are chiefly referable to disturbance of function of the cord.

The immediate danger to life in this disease is not great, though complete recovery does not occur. The treatment consists in removing, if possible, the exciting cause, in putting the patient on a water-bed, administering counter-irritation over the seat of the inflammation, in giving small doses of ergot of rye and iodide of potassium, and, when the acute stage has subsided, nerve stimulants and electricity.

Chronic myelitis is a later and progressive stage of the affection just described.

Nervous Prostration.—See *Neurasthenia.*

Neuralgia is a painful affection of the peripheral nerves. It differs from neuritis in that the disturbance is functional, not inflammatory, while in neuritis the structure of the nerve itself is altered. Some forms of neuralgia, for example sciatica, very often become true neuritis.

Young adult females are the people most commonly affected with neuralgia, and it is often difficult to find any direct exciting cause. Such causes should, however, always be looked for. While any sensory nerve may be affected by neuralgia, the nerves most commonly involved are the trigeminal, the intercostal, and the sciatic.

1. *Trigeminal Neuralgia.*—In neuralgia of this, the fifth nerve, the pain is located about the eye and the region of the face immediately below the eye, and it may radiate from these regions. The pain is intense, and comes in attacks lasting several days. There will also be swelling and watering of the eye of the affected side, and at certain points the slightest pressure will cause intense pain.

The first object in treatment is to look for any possible exciting cause. The eyes should be examined, ear disease excluded, and the condition of the teeth carefully attended to. Then the general health of the patient will generally be found to be imperfect. For improvement of this, tonics may be administered, such as iron, arsenic, cod-liver oil, and, if possible, a temporary change of climate, with out-of-door life. For the attack itself, some counter-irritation over the seat of pain is often useful—viz., a mustard leaf or a small amount of cantharides, with collodion painted on with a brush. Cocaine cataphoresis—a solution of cocaine introduced by means of the galvanic current—has proved of benefit in the hands of skilful physicians. The drug which has proved most efficacious is aconitia given in small doses, and increasing the doses. Its administration, however, must be attended with great care, and taken only under medical

direction. Phenacetine, antifebrin, and the bromides are sometimes helpful. The condition is, however, an obstinate one, and old and rebellious cases are sometimes forced to have part of the nerve cut away. This operation, which is a serious one, is not always successful.

2. *Intercostal Neuralgia.*—In intercostal neuralgia the pain follows the course of the intercostal nerves. The pain simulates that of pleurisy, and often a diagnosis can be made only by the negative result of examination of the lungs. Firm pressure at the posterior extremities of the intercostal spaces will generally elicit sharp pain, radiating forward.

The course of this form of neuralgia is similar to that of the trigeminal form, and its treatment is about the same. The best counter-irritant in intercostal neuralgia is the actual cautery.

3. *Sciatica.*—The great sciatic nerve issues from the pelvis at the inner part of the buttock and goes down the back of the thigh. Above the knee joint it divides into two branches, one of which continues down the back of the leg, the other down its outer side to the foot. Neuralgia of this nerve appears more often late in life than the other two forms mentioned, and is common in individuals exposed to cold and wet and to overstrain of the legs.

The pain, which is constant, though becoming much more severe at times, is distributed over parts of or the whole of the nerve's course. The duration of the disease is very tedious—three weeks to a year, or it may become permanent, so that the sufferer is bedridden.

If treatment is begun at the beginning of a first attack, the prognosis is good. The patient should go to bed and not bear any weight whatever on the affected limb until all pain has been absent for several days. A long splint, reaching from the foot to the armpit, is a valuable aid. If he must walk, let him use crutches. Dry or wet cups should be applied over the painful area, and the bowels kept open. These simple measures will often result in a short time in a permanent cure.

When the disease has become more chronic, rest, while still essential, will not give such permanently good results. Then counter-irritation (cautery), tonics, etc., must be tried. Oftentimes quinine in large doses (ten grains three or four times a day), combined with iodide of potassium, is beneficial. Operation on the nerve rarely results in a permanent cure.

The intractability of an old sciatica is due to the fact that a neuralgia of this nerve has a strong tendency to become a neuritis, the functional disorder changing into a true inflammation. If a person with his first attack of sciatic pain could be brought to realize this fact he would readily see that a few weeks lost in bed at the outset was, after all, a valuable economy.

I would be unwilling to leave the subject of neuralgia without two words of caution. One, which regards diagnosis, is to call attention to

the fact that pain along a nerve trunk may mean far more than a functional disease of the nerve itself. The second cautionary word regards the treatment of temporary pains with morphine.

Neurasthenia, or nervous exhaustion, is a very common disease, especially in the United States. It occurs in young adults of both sexes, and is more prone to occur in those whose ancestors have suffered from some form of nervous disease. Its advent is favoured by excesses of any kind, whether participated in in the performance of duty or in the pursuit of pleasure. Organic lesions in any part of the body may act as a causative factor, and often some slight bodily irritation (eye strain) may be sufficient to excite the disease.

The chief symptoms are impaired memory, defective will power, a continual anxiety over the personal condition, depression, loss of interest in surroundings, and inability for continuous application of the attention. Headache is usually present in a slight degree and the sleep may be disturbed. There is great "nervousness" over trifling accidents or sudden noises which cause palpitation of the heart and a trembling of the hands and fingers. There are alternate flushing and paling of the face, and the hands and feet are cold. The muscular strength is impaired. From these general symptoms various fairly well-defined types may be separated.

There is a gastro-intestinal form, in which gastric dyspepsia and constipation play the most important rôle, and a sexual form, in which the patient pays too much attention to his genital organs. The cerebral form is the most serious, coming as closely as it does to the border land of insanity. In this variety we find the morbid impulses and imperative conceptions, which certainly are not the results of action of a sane mind, and the various unjustifiable fears. In women the disease is very often characterized by the great loss of will power. Many women who have not left their bed for years are neurasthenics with sound organs, who could walk if they would, but the power of willing to walk is lost to them.

The more simple forms of neurasthenia can easily be cured, provided it is possible to remove the exciting cause and to apply rational treatment. Patients with the cerebral form, being almost always people with a marked neurotic taint, will probably never have an entirely normal nervous system, although they may be very much improved. In either case the treatment must be continued over several months. As already stated, the removal of the exciting cause in the treatment of neurasthenia is a necessity, without which other means will surely fail. Every possible local condition which might cause the disease must be looked for—viz., ocular defects, dyspepsia, etc. The food should be good and there should be plenty of it. Only such articles as the patient can not digest need be eliminated from the diet list. Baths are by far the most useful remedial agent. They are most efficacious if given in the form of a spinal douche,

first of hot water (110° Fahr.) which is suddenly changed to cold (50° Fahr.). This variation of hot and cold may be continued for five to seven minutes. In case douches can not be had, a similar effect may be produced by sponging, the patient standing in a bath tub or foot tub. The head should always be wet first with cold water.

Exercise, preferably in the open air, good in the house with a "health-lift" or Indian clubs, is an important ally of the bath. Massage and electricity may be given when exercise is not possible. Bromides and other sedative drugs are to be used very sparingly. The most valuable drugs are the nerve tonics—arsenic, strychnine, iron, or phosphorus.

Neuritis is an inflammation of one or more nerves. When more than one nerve is involved the disease is termed *multiple neuritis*. It is caused by exposure to cold or wet, by poisons (alcohol, the metallic poisons), and by infectious organisms which have found entrance to the body. Influenza is often followed by multiple neuritis, and neuritis of the nerves of the throat and the heart is a common sequel of diphtheria.

The symptoms vary according to the cause and the kind of nerves attacked. Bell's palsy, or neuritis of the facial nerve, is painless, as the nerve is purely motor in function. Multiple neuritis—as here both sensory and motor nerves are involved—is very painful and accompanied with paralysis. This paralysis, attacking as it generally does the muscles which extend the hand and flex the foot, causes the condition known as "dropped wrist" and "dropped foot." The paralyzed muscles waste rapidly, and there may be disturbances of nutrition of the skin. The control of the bladder and rectum is never lost. The course of neuritis, though always slow, tends usually to recovery. Alcoholic neuritis is rarely cured before six months or a year.

The treatment is symptomatic. If the muscles are not too tender, electricity should be used. Rest is essential. The general health must be maintained with tonics, and recovery may be somewhat hastened by the use of strychnine.

Paralysis may be defined as the loss of power of voluntary movement. It is a symptom and not a disease. Injury or destruction to any motor nerve, or group of motor nerves, will result in impairment or loss of voluntary motor power. A slight degree of paralysis is usually called muscular paresis.

Paresis.—See *Paralysis;* see also *Paralytic Dementia.*

Petit Mal.—See *Epilepsy.*

Poliomyelitis.—See *Infantile Spinal Paralysis.*

Sciatica.—See *Neuralgia.*

Sclerosis means literally a hardening, and is applied to the nervous system when nervous tissue is replaced by new tissue. It sometimes occurs as a definite disease called *multiple sclerosis*, in which areas of

sclerosis occur throughout the cerebro-spinal axis. The symptoms which it presents are a tremor elicited by intentional movements which ceases when at rest, stiffness and weakness of the arms and legs, with increased tendon reflexes, an oscillation of the eyes (nystagmus), and scanning speech.

The course of the disease is very long, and there is no specific treatment.

Sleeplessness.—See *Insomnia.*

Softening of the Brain.—This term is used by physicians to express a condition different from that popularly understood by it. Softening of the brain in a medical sense is when the blood supply to any part of the brain is shut off. This failure of blood supply occurs as a result of disease of the walls of the blood-vessels, which causes the blood to clot and thus interfere with the blood current, or when from any cause a foreign body or blood clot is carried from some other part of the circulation to the blood-vessels of the brain, and plugs the blood-vessels. As a result, the parts of the brain supplied normally by the occluded blood-vessel are cut off from their nutrition and die. Such a death in the brain is called softening. The condition occurs in old people and in the infectious diseases, or as a result of the warty vegetations of heart disease becoming set free in the blood stream.

The effect on the brain is loss of function of the part softened, an evil necessarily irreparable. Brain softening and general paresis are not synonymous terms.

St. Vitus's Dance.—Chorea, as this disease is technically known, occurs almost exclusively in children. Neuropathic heredity predisposes to its acquisition, and fright and excitement are the most common exciting causes. It consists in spasmodic contractions of the muscles of the body in greater or less number, according to the severity of the attack. Rarely it is limited to one side (hemichorea). The tongue is involved, causing difficulty of articulation, and, as a result of the disordered movements of the extremities, there may be considerable weakness of the limbs. The movements cease during sleep. The disease is generally a mild one, though rarely cured under five or six weeks. The great danger consists in the frequent complicating inflammation of the lining membrane of the heart, giving rise to valvular disease of that organ. There seems to be a relation between rheumatism and chorea.

As to treatment, the child should be taken from school and shielded from all exciting or disturbing influences. Recovery will occur more rapidly if the patient is kept in bed, and in any case he should not be allowed to get up until late in the morning. Arsenic is the drug generally prescribed, and sometimes it seems to have almost a specific action. Bromides and chloral may also be used. There is no known specific for preventing the cardiac complication.

Tetanus.—See *Surgical Injuries and Surgical Diseases*, Chapter II.

Tic Douloureux is an affection characterized by attacks of very sharp pain over one side of the face. During the attack—which lasts one to two minutes—there is first paleness, followed by flushing of the face, watering at the eyes, and perhaps a fine tremor in the parts about the affected area. The patient may have many such attacks a day, and again may go for some time with no attacks at all. The disease is essentially chronic and rebellious. Here, as in facial neuralgia, aconitia is the most useful drug.

Torticollis.—See *Wryneck.*

Tremor is a vibratory and unintentional muscular movement. It is a common and important symptom in nervous diseases, and its various forms have been described in the individual diseases in which it occurs.

Vertigo, or dizziness, may be due to a variety of causes, chief of which is disease of the ear. Anæmia or impoverishment of the blood and torpid liver may also cause it. It is a very common symptom in diseases of the brain, especially of the cerebellum. Its treatment must be altogether directed toward its exciting cause.

Wryneck, or torticollis, is a chronic spasmodic affection of the muscles at the sides and back of the neck. It may be bilateral or may occur on one side only. As a result of the muscular contraction the head is drawn forward and sideways toward the affected side. The disease is rarely cured; the various antispasmodic drugs may be tried with this end in view. This disease has been the subject of much surgical discussion, but the results furnished by operation are far from satisfactory.

INSANITY.

Insanity is not a clinical entity—that is, it is not a disease in itself, but a symptom of disease. A fairly good definition of insanity from the medical standpoint is that it is a manifestation in conduct or speech of disease or defect of the brain. Insanity may be divided into two great groups—one, where it comes on in youth or adult life in a person born with a normal brain, and one group composed of all such individuals as are born with defects of the brain.

Definition.

I. Diseased brains.

II. Defective brains.

Under the second heading we would place all cases of congenital idiocy, imbecility, and feeble-mindedness. These words express degrees of defect. The idiot is the most defective mentally; the imbecile is moderately defective; the feeble-minded is one who shows merely weakness of the intellect. To the first group belong the vast majority of cases of insanity. Any one who visits an asylum for the insane is struck with the diversity of expres-

Classification of Various Forms.

sions in the faces of the inmates. He sees at once that there are various kinds of insanity. From mere observation of physiognomy he would select the gloomy visage of the *melancholiac* who is in a condition of deep mental depression. Another class, rather lively, active, excited, and exalted, presents the maniacal state (*mania*). There would be many patients, too, who would show in their expression, speech, and demeanour a condition very like idiocy, yet we do not call them idiots, for their condition is not one of congenital defect, but an enfeeblement of the mind known as *dementia*, following some acute brain storm like melancholia or mania. It is often termed *secondary* or *terminal dementia*, and is absolutely incurable. The word dementia often appears in newspaper language as synonymous with insanity, but the word should be restricted to the state of mental feebleness just described.

Still another class of cases is that known as *general paresis*, which is a gradually developed dementia or enfeeblement of the mind combined with a progressive paralysis of the body; hence the term *paralytic dementia* often applied to this class.

Finally, there is a very interesting class of cases which used formerly to be called monomania, but is now denominated *paranoia*. In this form there are fixed delusions of persecution or grandeur.

Most forms of insanity are comprised in the above statement, but physicians are wont to speak of acute or chronic mania and acute or chronic melancholia. There are also many subvarieties, such as hysterical, puerperal, lactational, senile, epileptic, recurrent, periodical, circular, and so on.

Home or Asylum Treatment.

As regards home or asylum treatment a few words should here be said. Just as a hospital is a better place than a tenement house for a surgical patient or a case of fever, so is the asylum superior to the home in the care-taking of the pauper and indigent lunatic. The acutely insane of the poorer classes are best treated at present in large State institutions; and those of the moderately well-to-do either at home or in the small private asylums. Only the insane of the wealthy classes can perhaps enjoy and carry out ideal methods of treatment in their own homes, in country houses, or in foreign travel.

It is, of course, needless to say that there are many degrees of insanity; that there are hundreds of cases that are never obliged to go to an asylum at all; that in society are many insane people carrying on legitimate occupations, and caring for themselves and families; and that, on the other hand, there are cases for which nothing but commitment to an asylum would be suitable or feasible.

The sooner a case of acute insanity occurring in a pauper or indigent is removed to an asylum the better are his chances for recovery. With

cases of acute insanity in those who are able to afford the expense of trained nurses at home the case is different. It would seem unfortunate to have to send a patient to a large asylum, with its locks, its bars, its associations, its overcrowding, its commingling of the intelligent and the refined with the offspring of the slums, and its inevitable stigma, when the case may prove to be mild, with an early recovery. How much better to make the trial of treatment at home! Naturally the responsibilities of the physician are often great with an insane patient in a private house, and it is certainly true that the asylum seemingly affords considerable protection from death by exhaustion, suicide, and the like. I say *seemingly*, for this protection is really not as efficient as is generally supposed. From the annual reports of the New York State Commission in Lunacy I gather that the number who die from exhaustion in the public asylums of the State of New York yearly is much over one hundred and fifty, and that the number of suicides of patients committed to their care is in the neighbourhood of fifteen per year. These facts are noted merely to show that the asylum is not an absolute protection against the death of a patient by exhaustion from mental disease or suicide, and that in view of this we may treat many patients at home with a clear conscience, and with little greater risk, always providing that the room and the nurses and minor essentials are at our command.

I believe it is not fully appreciated how much the asylum authorities are striving to do to effect improvement in the methods of management of the insane. Not only is the asylum itself undergoing a metamorphosis, but managers are actually doing all they can to extend the treatment of the insane *outside* of asylums.

When people are sufficiently well-to-do the ideal methods of treatment are, of course, to be found outside of an asylum. The insane of this class may be treated at home, or in a seashore cottage, in a country house, or they may go travelling in the charge of a physician and a nurse. The kind of treatment best adapted to the nature of the case must be decided by the physician. The quiet of a private house in the city or country is best for some cases, while the tonic and stimulus of foreign travel are indicated in others. It may be stated that when travel seems to be the prescription required, the greater the change from the environment in which the mental disorder developed, the better. The cities of Great Britain and the Continent do not differ essentially from our own cities, and patients should not be sent to such places with the idea of securing a change of environment. Norway or the Yosemite in summer, and Egypt or Mexico in winter, are regions which offer the greatest inducements in the way of tonics to the nervous system and stimulus to the mind, and all of these are at the same time peculiarly restful and calmative.

If these methods of home, country house, or travel are for any reason

impracticable, then the smallest private asylum that can be found is to be selected, for the fewer other insane people and the greater number of sane people the patient comes in contact with, the better will be his chances for recovery. There is a need for physicians in practice in the country who will be duly authorized and empowered by law to receive in their own homes and care for one such patient. The chief drawback in home treatment, if long continued, is usually the bad effect of association with an insane person upon other members of his family, particularly if they be neuropathic. With a sufficiency of nurses and room there is no contingency in the treatment of the insane that can not be guarded against. These being provided, the worst features in a case, such as violence, homicidal and suicidal tendencies, attempts at self-mutilation, etc., may be as well avoided outside as inside of an asylum. There are cases in which, though I am opposed to mechanical restraint in great measure, I should employ long-sleeved nightgowns, or even camisoles, rather than let them go from home before all means of cure had been tried at least for a few weeks' time.

The conditions and propensities that we have to combat are many. The choice of method must be the result of careful deliberation, and after judicial survey of all the features presented. We usually need the assistance of skilled and experienced nurses. Thanks to the asylum training-schools, there are numbers of such trained nurses of both sexes to be had in the large cities of the United States.

In acute cases, whether of mania or melancholia, it has been my experience that confinement to bed is a valuable factor in cure. Hence, on being called to such a case, I have the patient put to bed. Due precautions are taken as to the removal of all sharp instruments, weapons, drugs, cords, door keys, and the like, and by a simple device the windows are so arranged that they may not be opened beyond six inches; otherwise the furnishings may be left as they are without attention.

Insomnia and mental and motor excitement most frequently demand our best skill. Often, indeed, it is necessary to use powerful drugs hypodermically, but for routine treatment of insomnia and maniacal excitement I much prefer hydrotherapy to drugs. In some cases the prolonged warm bath (70° to 90°) for from half an hour to two hours may be used, but in all cases the hot wet pack is applicable. For full details as to these procedures see *Insomnia* above.

In acute depressed conditions, on the other hand, certain opiates usually act best in cases in which hydrotherapy does not subdue the insomnia, distress of mind, and disordered nervous system. Among opiates, codeine seems to offer advantages over others, and the contraction of a habit need not be feared, but it should never be given without medical supervision. The refusal of food is another element of danger. Acute

insanity, besides rest in bed, quiet and repose, needs overfeeding to balance the great waste of tissue going on in the system. While many cases of acute mania will eat and drink ravenously at times, from the nature of things their actions are uncertain, and the nurse should be instructed to feed the patient almost hourly and keep account of what is given. Milk, raw eggs, meat juice, and occasional stimulants, must in extreme cases be our chief reliance. Having an intelligent and assiduous nurse at hand, the necessity of feeding with a tube will only rarely occur. When required, the soft-rubber stomach tube may be introduced by the physician through the mouth or nose, a funnel attached, and the liquid mixture of the substances named allowed to flow in (see *Medicines and Treatment*, Fig. 9). I can not here refer to many other morbid conditions that must be met by appropriate medication, and by moral treatment as well in acute as in subacute and chronic forms of mental disorder. There are cases (some of the insanities of puberty and adolescence, and other forms) in which anaphrodisiacs modify distinctly the trend of delusions. There are cases in which intestinal antiseptics achieve noteworthy results; indeed, the instances are few in which attention to morbid states of the alimentary canal is not rewarded by considerable benefit to the mental condition of the patient. Arguments with patients upon delusions more or less fixed in character often has, despite the opinions of numerous alienists to the contrary, decided value in altering their beliefs, and at times even eradicating their insane ideas altogether. It is true that occasional argument is generally of no avail. Such moral treatment must be sedulously and perseveringly employed, daily and for weeks or months, to insure success. Argument is a species of suggestion. *Never should the patient be encouraged in his delusions or deceived in any manner whatever.*

We will now proceed to define the more important forms of insanity and some of the symptoms in alphabetical order:

Adolescent Insanity.—This form is nearly always one of exaltation —in fact, a mania. It appears between the ages of eighteen and twenty-five years. The patient is exalted, talkative, restless, sleepless, excited, has no appetite, and is sometimes vicious. Sexual matters often seem to have much to do with the origin of this form. Recovery is usual in these cases, though relapses are very frequent. The neurotic heredity is common. No attempt should be made to treat such cases at home, except under the direction of an experienced physician. They do better in a sanitarium or asylum than elsewhere.

Alcoholic Insanity.—The commonest form of alcoholic insanity is a violent delirium with homicidal tendencies. Another name for it is *mania a potu*. Sometimes instead of a maniacal condition there is a state of melancholia with suicidal tendencies.

Delirium tremens is a particular form of acute poisoning by alcohol, in which there is great tremor of the body and delirium, with marked hallucination. The hallucinations of seeing animals, snakes, insects, etc., are especially prominent.

Chronic alcoholic insanity is manifested by insomnia, tremor, dreams, hallucinations, delusions, and either a depressed or an exalted maniacal state. Delusions of persecution are especially common.

The most that can be done at home with such cases is to cut off the alcohol sharply, and follow the advice of the attending physician closely. Hospital or asylum treatment is always best.

Amenorrhœal Insanity is a name given to the melancholia or mania which sometimes develops by the disorder or suspension of menstruation.

Choreic Insanity is a form of insanity developed occasionally in cases of chorea or St. Vitus's dance. Sometimes the patient is depressed, sometimes excited, but rather more often in a stuporous state.

Circular Insanity is a form in which maniacal and melancholic conditions alternate and follow each other without interruption.

Climacteric Insanity is insanity developing at the period of change of life. It may be either mania or melancholia.

Delusion.—A delusion is a false idea or belief out of which a person can not be reasoned by adequate methods. Delusion and hallucination are not synonymous terms in medicine. (See *Hallucination.*) Delusions may be transitory, but in many cases of insanity they become fixed or systematized, and the patient may give pseudo-logical reasons for them. Among the commonest fixed illusions are those of persecution and grandeur. A patient believes he is followed by detectives or enemies, that they try to poison him, to influence him by hypnotism or electricity, etc. Others believe they are enormously wealthy, that they are the Saviour, the Virgin Mary, prophets, kings, queens, great reformers, and the like. In melancholia there are usually temporary delusions (though they may become fixed), of a depressed character, that everything is ruined, that their friends are all dead, that the patient is going to be killed, that he has committed the unpardonable sin, and so on.

Dementia.—This has already been mentioned as a term generally employed to represent the imbecile character of the mind after the passing away of some acute form of insanity, such as acute mania or acute melancholia. It is a condition of mindlessness, so to speak, though it varies in degree, and some vestiges of the former mental state may remain. While it is, as a rule, a terminal state, or a dementia secondary to an acute insanity, sometimes an acute general weakening of the whole mind may take place, particularly in youth, and this has been called an acute or primary dementia.

Hallucination.—A hallucination is the perception by one of the five

senses of an object which has no existence. If one fancies he sees an object which is really not before him he has a visual hallucination; if he hears a sound when all is still he has an auditory hallucination; if he smells bad odours, though none such are about, he has a hallucination of smell; and in the same manner the hallucinations of taste and feeling. Hallucinations are to be carefully distinguished from illusions (which see). Auditory hallucinations are often popularly called "false hearing." Hallucinations are met with in a great many cases of insanity, and the most common are those of sight and hearing.

ILLUSIONS are perverted or transformed perceptions. Thus a patient may see, hear, taste, smell, or feel an object, but as something else than it really is. An illusion is a false perception.

IMPERATIVE CONCEPTIONS are ideas which take complete possession of the mind and tyrannize over it. They differ from delusions in that the patient may be able to reason himself out of the imperative conceptions at times.

MANIA is a mental exaltation or delirium, generally accompanied by delusions, by great restlessness and muscular excitement, by loss of self-control, by great loquacity, incoherence, and noisiness. Such cases are usually best treated in asylums, where they can be kept in bed, made to sleep by baths, wet packs, or drugs, and be properly fed. In cases treated at home either several nurses are needed (two for the day and two for the night), or the camisole or strait-jacket is required.

MELANCHOLIA is exactly opposite to mania. The patient begins to feel a lowness of spirits, lack of interest in amusement or occupation, and gradually the dejection increases until he has a feeling of anxiety, gloom, oppression. He is quiet, indisposed to stir or to answer questions. The intellect becomes slow and sluggish in action. He begins to have false ideas, to brood over imaginary sins, to have morbid apprehensions, to seclude himself from people, to wish to die, to hint at or attempt suicide. There are various kinds of melancholia. A mild type without delusions is termed simple melancholia. Then there is a melancholia with stupor, where the mental apathy grows deeper and deeper until the patient is as if in a trance state. In melancholia with frenzy the morbid state of the mind, the dreads, the horrible thoughts, and frightful hallucinations or illusions, drive the patient wild. He rushes up and down in a frenzy to escape his danger and doom.

Early isolation of cases of melancholia is of paramount importance. They should be removed from home, to some private cottage, sanitarium, retreat, or asylum. Unceasing vigilance is needed in these cases to prevent suicide. All cases of melancholia suffer much from constipation, and the bowels require constant regulation. Melancholic patients refuse food, as a rule, and often have to be forcibly fed, or exhaustion ensues.

MONOMANIA.—See *Paranoia.*

PARALYTIC DEMENTIA, or general paresis, is a form of insanity popularly but erroneously called "softening of the brain" (which see). The onset of this disorder is protean in its manifestations. The earliest symptoms may be either physical or mental, or both. Tremor of the fingers and of the hand in writing; fibrillary tremor of the lips and tongue; slight difficulty in the pronunciation of certain words, such as "third cavalry brigade"; irregularity, inequality, or smallness of the pupils—these are among the earliest symptoms. Later these become more and more pronounced and others are added.

The mental symptoms vary very much. At first there may be a little melancholia or hypochondriasis. This is more common as an early symptom than the feeling of well-being and personal aggrandizement, which almost always makes its appearance at some epoch in the course of the disease. Loss of memory, certain incongruities of conduct, emotional weakness, misplaced and inappropriate use of words—these are among the most frequent early mental manifestations. Occasionally there may be a sudden outburst of a maniacal state. Convulsions and attacks of apoplexy are apt to occur in nearly every case in the later stages of general paresis, but they may make their appearance in the very earliest periods. The disease is an absolutely fatal one, and progresses constantly. No case was ever cured, though intervals of improvement known as remissions are occasionally observed. The average duration of the disease is two to five years, though some cases run a much more rapid and some a much more slow course.

The disease is one of the few kinds of insanity in which visible changes are observed in the brain after death.

As regards treatment, the physician must determine the appropriate agents in each case according to the symptoms manifested. Many cases can be treated in the early stages at home, but all become bedridden and more helpless than babes at last; hence a sanitarium, retreat, or asylum is best toward the end, for here they have the trained supervision and proper appliances for their care.

PARANOIA.—In a typical case of paranoia there will be found hereditary taint, possibly peculiarities of the shape of the head or of the physiognomy (degenerative stigmata), eccentricities in childhood, more marked peculiarities during youth, often associated with hypochondriasis, and at about the age of thirty—sometimes earlier, sometimes later—the growth and systematization of delusions of persecution, which may in turn be combined with or give place to fixed delusions of an exalted character (religious, philosophic, patriotic, or erotic). (See *Delusions.*) Such delusions completely dominate their entire mental action without impairing every faculty. These cases used at one time to be called cases of mono-

mania, but as they usually have more than one delusion—in fact, a cluster of delusions—that term has fallen into disuse. The English authorities call it *delusional insanity.* The eccentric individuals popularly known as "cranks" are without doubt imperfectly developed cases of paranoia. Italian writers speak of these imperfectly developed cases as *mattoids.* Paranoiacs often have considerable talent, or even genius. I have several autobiographies of paranoiacs in manuscript form which evince literary ability of no mean order. There have been paranoiacs famed in national annals and in literature, such as some of the rulers of Russia, Austria, Bavaria, and Spain, and the cases of Louis Riel, Guiteau, Swedenborg, William Blake, Joan of Arc, Benvenuto Cellini, John of Leyden, and others. For studies of some of these the interested reader is referred to Dr. Ireland's *The Blot upon the Brain* and *Through the Ivory Gate.*

As regards treatment of these patients, little can be done except, perhaps, in the way of moral methods, and these are of most value in the earliest stages. Eccentric and peculiar children should be carefully watched and studied by physicians familiar with mental disorders with the idea of being able to prevent the development of insanity. The asylum is the destination of most paranoiacs, and in the best of these institutions the discipline, employment, recreation, and regularity of eating, sleeping, and exercise, exert a beneficial influence upon the course of the disease. As many paranoiacs have dangerous or homicidal tendencies, they need to be carefully examined, especially those with persecutory delusions, in order to determine the presence of ideas of retaliation and vengeance upon their imaginary persecutors. If there is any suspicion of their possessing dangerous proclivities they should, of course, be deprived of their liberty as soon as possible.

Paresis.—See *Paralytic Dementia.*

Puerperal Insanity is insanity (sometimes melancholia, sometimes mania) developing during the puerperal epoch. There are three kinds—one the insanity of pregnancy, one the insanity of parturition (developed within a month after childbirth), and finally the insanity of lactation.

Senile Insanity is a mania, melancholia, or dementia (usually the last) developing in old age.

XII.

MEDICINES AND TREATMENT.

By HENRY A. GRIFFIN, M. D.

INTRODUCTION.

Our entrance into life is painless and in unconsciousness, and it is not until long after birth that there occurs in us a gradual awakening to the knowledge of our existence. If, therefore, Nature has provided for our comfortable beginning, it seems but reasonable to suppose that she designs a similarly easy ending; and that as consciousness appears and develops during childhood, so it should grow less and disappear during old age, keeping pace with the natural development of the body in childhood and its natural decline in old age, until life ceases in unconsciousness and as painlessly as it began. Viewed thus, childhood is life's awakening and old age its falling asleep, while birth and death are both physiological, the one life's beginning, the other its end.

So far as it concerns the child, birth is generally physiological; but life is seldom so, and death practically never.

That life and death are thus changed, from the natural to the unnatural, is due to disease and to the combating of disease and the attainment of the physiological life and death are our efforts more or less earnestly directed. In our combat with disease two courses are open to us—to prevent and to treat.

THE PREVENTION OF DISEASE.

No truer words were ever written than "an ounce of prevention is worth a pound of cure"; and though we may indeed be unable to prevent and must then attempt to cure, yet it is self-evident that prevention is the first to be attempted, and thus the more important. The prevention of disease has been the object of the medical profession since the earliest times, but only with the more scientific investigations of recent years, and the consequently more thorough understanding of the nature and character of morbid processes, has prevention attained to any great effectiveness,

and even now its attainment is by no means complete. Certain means effective in preventing disease have, however, been discovered, and in personal and public hygiene, quarantine, isolation, disinfection, vaccination, preventive inoculation and preventive medication, we have at our command agents powerful to protect. Preventive treatment, or *prophylaxis*, as it is termed, must therefore be considered by us in order that the completeness of our article shall not be sacrificed, and though prevention and treatment apply to surgical as well as to medical conditions, yet the latter alone will receive consideration in this article, and for surgical information the reader is referred to another portion of this book. (See *Surgical Injuries and Surgical Diseases.*)

Habits as Causes of Disease.

To say that the exercise of common sense will protect us against many a disease is perhaps as unnecessary as it is self-evident, and yet, while we all would avoid the eating of foods known to contain poison, the risk of incurring contagious disease, and the deliberate exposure to cold and wet, there are many abuses to which the intelligent subject themselves habitually, the penalties of which are as severe as those of the things we have mentioned. Among those habitual abuses none is more potent for harm than is improper diet.

Forms of Food.

Three forms of food are found to be essential to the maintenance of health—fats, sugary and starchy matters, and nitrogenous matters, which occur, for the most part, in meats. In some articles of diet all these occur, in others but two, and in others again but one. In no one food, however, is this mixture such that a diet confined to that food will give us the proper proportion of the three necessary ingredients, save only the mother's milk when used by the infant. It is from a failure to appreciate this truth that the so-called vegetarians have been led into error, for a strict adherence to their doctrine necessitates an abstinence from animal food, and while we may, indeed, obtain the nitrogenous matter from vegetables, yet its proportion in them is so small that to obtain the requisite amount we are compelled to use such quantities of vegetables, the main ingredient of which is starch, as to overload our digestive systems with that substance, and this results in digestive overwork and ultimately in digestive and bodily impairment.

Diet.

In diseased conditions, indeed, it may be necessary to abstain from one or another form of food, an example of this being seen in the necessary avoidance of sugary and starchy foods in saccharine diabetes. In health, however, a mixed diet is invariably the best, and of the proportions of that mixture both our education and our experience will teach us. It is not the purpose of this article to deal exhaustively with foods; but it may be stated as a general rule that the sugars and the starches are to be used only in modera-

tion, since they are of less value than are the nitrogenous matters and the fats. In their overuse, too, they are productive of the greatest harm, whether that harm be illustrated by the indigestion following a candy debauch, or by the more chronic and serious disturbances following their continued abuse, of which chronic dyspepsia and gout are examples. The meats are next most liable to overuse and consequently to abuse, while least harmful of all are the fats, the greatest of whose penalties lies in an unfashionable obesity.

Regularity in Eating.

The importance of regularity in eating can not be overestimated, and while for some few a morning and an evening meal will suffice, for the large majority of people the customary three meals a day are requisite. That these should be taken at stated hours each day and separated by regular and constantly kept intervals is probably generally appreciated; but many people who in other respects educate their children wisely and well, educate their stomachs to the grossest sort of wilfulness and misbehaviour, for they forget that the stomach acquires bad habits and retains them, as does the individual. *A thorough training in dietetic regularity, therefore, is of prime importance for the preservation of health.* The habit of "eating between meals" is in general to be strictly avoided. While the delicate are often unable to take at their customary three meals amounts sufficient to sustain them in the intervals, and therefore they may be allowed a biscuit or a glass of milk "between times," or may even take six small meals instead of the three larger ones, yet in health the practice is unwise and harmful. So is the habit of eating before going to bed; and though some conditions warrant us in permitting or even encouraging this practice, the most important among them being nervous sleeplessness, yet in such cases a morsel will suffice, and a hearty meal must never be allowed.

Overeating.

The appetite is not a trustworthy guide to physiological eating unless it shall have been physiologically trained from our earliest days; for, especially in early years, the individual will feel hungry about as often as he sees toothsome food. That the head must govern the appetite is clear, and in no way can it more wisely do so than in the prevention of overeating. This is largely a matter of habit, and while we too often hear the words "I love to see a person with a good appetite," the exhibition which calls them forth is usually one of continued and excessive eating, not because the individual needs so much food, but simply because the food tastes good. To eat thus, and to rise from the table with a sense of satiety and fulness, can not be too strongly discouraged; and while the author can not agree with those who recommend rising from the table while still hungry, he is thoroughly convinced that overeating is more dangerous than is undereating, and can tes-

tify to the direct relation between gluttony and incurable disease. As a rule, people eat far too much, and in nothing is moderation more important than in eating.

Hasty Eating.

Haste in eating is a thoroughly unnatural and harmful practice, but one which is unfortunately far too common in America, where haste and hurry make all things unphysiological. It is self-evident that our teeth were given to us for the purpose of dividing our food into such small particles as would make them more easily digestible. The failure to observe this provision of Nature, therefore, results in the swallowing of food in pieces so large and undivided as to hinder or prevent the digestive juices from penetrating and digesting them. In many animals this fine division is not necessary, since in them the gastric juice is of such strength that even the toughest and densest of foods are penetrated and digested. With man this is not so, and the failure properly to chew or divide the food soon results in dyspeptic and other diseases. Chewing must therefore be thorough, or, in the absence of teeth—as in old age—the fine division of the food must be accomplished otherwise.

Another reason for slow eating is too little realised, for many are ignorant of the fact that the saliva is a digestive fluid, and that its mixing with the food is as necessary to perfect digestion, in its way, as is the action of the gastric juice. For these reasons, then, the habit of "bolting" our meals is harmful in the extreme, and its continued practice is responsible for many an ill.

Water Drinking.

The greatest diversity both in theory and in practice exists upon the subject of water drinking. No hard-and-fast rule can be given as to the requisite amount for the maintenance of health, for the amount needed will vary with the individual. A *moderate* amount of water taken with our meals is of great value in dissolving many of our foods and in promoting their absorption. The taking of *large quantities* of water with food is, on the contrary, unhygienic, since thereby the digestive juices are rendered more dilute and hence less active. Very cold water, too, has the disadvantage of reducing the warmth of the stomach, which is necessary to the perfect accomplishment of digestion, and while this action will be slight and soon overcome, if but small amounts of the iced water are taken, larger amounts may be productive of harm. The drinking of water between meals is, however, to be recommended, since its effect is to wash and cleanse and flush the tissues throughout the body, and thus to render them more healthy and more active. By this action it sweeps the collected impurities from the body, and in the increased amount of urine and perspiration produced by water drinking are thrown off excrementitious substances whose retention in the body would be productive of harm. Women in particular are

guilty of neglect of this wise use of water, possibly from the embarrassment connected with the necessity for more frequent urination. Young children, too, offer examples of this neglect, and it is simply astonishing that mothers should experience and gratify thirst in themselves, and never entertain the idea that their infants can be thirsty. And so, whenever the child cries of *thirst*, the ever-ready bottle is produced, and to obtain the drink he wants he is compelled to take the food he does not want, with the result of keeping his digestion ever acting and ultimately of producing its disorder. Not a little of the vomiting and diarrhœa of young children could be prevented by the occasional giving of a teaspoonful of cool water.

Water Drinking in Infancy.

The power of water to promote the activity of the bowels is not the least of its good qualities, and a cup of cold water taken on an empty stomach will often suffice to relieve the milder grades of constipation.

Pure Water.

If water, then, is so necessary for our continued health, its quality must be even more carefully considered than its quantity, since by contamination it may become the vehicle of infection and disease. If, therefore, any doubt of the purity of our drinking water arise, its use is to be avoided entirely, and bottled waters of known purity are to be substituted. It is not always convenient to do this, however, and so we may resort to purifying the polluted water by thoroughly boiling it (filtering is worse than useless), after which it may be cooled and drunk. Such precautions are especially required during the prevalence of cholera, diarrhœal diseases, and typhoid fever, for the poisons of these diseases are known to reside in water and with it to enter the body.

Exercise.

No man can continue healthy without exercise in some form, and though, as is the case with food and drink, some require more and others less, yet the practically complete avoidance of it results, as is seen every day, in digestive and nervous disturbances, loss of vigour, and, if continued, in organic degeneration and disease. (See *Physical Training*.)

The form of exercise must vary with the habits, time, strength, and requirements of the individual, and the most that can be done here is briefly to allude to the more common forms.

Walking.

Walking is within the power of all in health, and should be practised each day, and, if possible, at a regular hour. The pace should be brisk, and an effort made to have the whole body participate, so far as may be, in the exercise, that it may not be an exercise of the legs alone. The distance must be regulated by the effect upon the walker, for anything beyond a healthful weariness is to be avoided, while up to this point nothing but good can result from a continuance of the walk. To name a standard, then, is impossible, and a greater absurdity

than placing the required daily distance for a man in health at nine miles, as has been done by a German authority, can not be imagined. Like all other forms of exercise, walking, save of the mildest, should neither be done just after a hearty meal nor, on the other hand, upon an empty stomach.

Horseback Riding, Running, Bicycling, Rowing, and Boxing.

Horseback riding is an ideal exercise, since in it no one set of muscles is benefited to the exclusion of others, but all are brought into play. Moreover, the mental activity required is distinctly advantageous and the motion conducive to digestive vigour. Running, if not too violent or carried to the point of exhaustion, is an excellent exercise; beyond these points it is dangerous. Bicycle riding has many advantages; it is novel and entertaining; it is beneficial, too, if not excessively or violently done, but it has a serious disadvantage in the stooping position so generally assumed by those who "ride the wheel." Rowing, if done in moderation, is well, but if speed be attempted, especially for any distance, there result such great strains upon the circulation and respiration as to be the possible causes of serious mischief. Boxing is an admirable exercise, for in it all the muscles are employed and the mind as well, and by it are cultivated strength, agility, rapidity of thought, and control of temper.

Milder forms of exercise are more suitable for the young, for the delicate, and for women, and of these, tennis, golf, fencing, and dumb-bell and Indian-club exercises are examples. Whatever the form of exercise, however, let it be done regularly, not violently, and continued only until a healthful weariness is produced.

Cleanliness and Bathing.

Cleanliness is of the utmost importance as a preventer of disease, and, if possible, a bath should be taken each day. This daily bath should not, however, be a soaking, for in this there is no advantage, and, furthermore, there is produced a weakening of the body generally, and a removal of the oily secretions of the cuticle by which the skin is rendered less healthy and less active. A sponge bath or a brief dip or a shower should be the daily practice upon rising; the "soak" should not be employed more often than once a week. The temperature of the water used is of much importance, for while the weekly tub bath should be given warm and with soap, since thus is cleansing more perfectly effected, the daily dip, or sponge, though indeed cleansing, is more to invigorate, and therefore is more effective if cold.

Cold Baths.

Cold-water baths, however, cause in some people shivering, blueness of the fingers, toes, and lips, and a feeling of weakness. Such people should never take cold baths, and indeed persons vary much as to the degree of cold they can bear. Yet in many, a healthful glow follows the cold bath, and, with a feeling of in-

vigoration and warmth, constitutes the "reaction," and this is the surest evidence of the bath's value, without which such cold applications only do harm.

Stimulants.

If we spur a horse he will respond by increasing the power and rapidity of his movement, but if we continue the spurring from time to time, he will become accustomed to it and respond less actively, while if we incessantly use the spur he soon becomes exhausted by his efforts, and further spurring serves but to complete his exhaustion. It is so with stimulants, no matter whether the form be alcohol, tea, or coffee; their occasional use produces increase of nerve action, their more frequent use produces less response, and their habitual use, and especially their habitual overuse, produces a weakening and almost impotence of nerve structures. It is not intended to argue against the use of such stimulants, but simply against their abuse, for while individuals vary greatly in their ability to use them, and in some persons the slightest quantities act to disorder nerve function and are practically poisons, yet others bear them well and are benefited by them. *Excessive use is, however, dangerous to all.* A glass of wine with a hearty meal is often an aid to digestion, and especially in the aged, in whom circulation, digestion, and all nerve action are deficient in strength. A cup of coffee is similarly beneficial, as is a cup of tea, though both have the power to cause "nervousness" to a degree relatively greater than that caused by alcohol. Tea, too, has a marked tendency to cause constipation, and its general use by women, together with the little exercise they usually take, serves to account for the constipation so often found in that sex, together with its attendant ills. This power of tea is dependent upon the tannin the leaves contain, and the longer the tea stands or steeps, the more tannin it contains and the more constipating it is. The evil results, then, of drinking such a beverage can not be overestimated. It is all very well for the tea victim to call it the "cup which cheers but not inebriates"; but she deludes herself, for though indeed not intoxicated, yet she is constantly stimulated, thoroughly dependent upon a drug, and to all intents and purposes a drunkard. Alcohol is, of course, a more powerful drug, and one whose power to poison and to cause disease is more marked, but the principle is still the same whether in use or abuse.

Tea Drinking.

Alcoholism.

The continued overuse of alcohol causes incurable diseases, of which gout, chronic catarrh of the stomach, and Bright's disease may be taken as examples. Its occasional excessive use causes intoxication, but, so far as danger to life is concerned, the occasional drunkard is far better off than is the habitual "tippler." Not only does this habit cause disease, but it weakens one's resistance to any illness, since it so weakens the circulation (by lessening nerve force) that,

with the extra demands upon the heart in illness, especially if acute, that organ gives out under the strain and death results. It is of little use in such cases to spur on the weakened heart with wine and liquor, for, like the jaded horse, it feels the spur, indeed, but has no strength to respond. The frequency of death from pneumonia in alcoholic cases is thus explained.

Smoking.

That "what is one man's meat is another man's poison" applies to nothing more forcibly than to tobacco smoking. Some are injured by the slightest smoking, indigestion and "nervousness" being the penalty for the sin; while others really derive benefit from the after-dinner cigar, a mental soothing and digestive rapidity following. No rule, then, can be given for the safe or proper amount to be smoked. It is simply a matter for the individual to ascertain by experience and honesty with himself. Excessive smoking, there can be no doubt, is harmful in all cases, but what will be excessive for one will be moderate for another. Two or three cigars a day, smoked, not upon an empty stomach, will, in general, not be excessive. Pipe smoking, too, may be beneficial if done in moderation, but *no matter how tobacco is smoked, it should not be inhaled.* The most abominable form in which tobacco is smoked is the cigarette, and unless one can smoke cigarettes as infrequently as one does cigars, in moderation, and without inhaling, they should not be allowed. It is not the paper which does the harm—that is practically innocuous; but the evil effects are due to several reasons: first, because they are so cheap that economy exercises no restraint upon the number smoked; second, because they are generally inhaled; third, and most important of all, because of the well-known fact that, to produce the greatest effect from a given drug, it is given, not in large and long-separated doses, but in small amounts frequently repeated. For the last reason the system of the ordinary cigarette smoker is practically never free from tobacco. The harmful results from such continued saturation may be inferred. Of tobacco chewing it suffices to say that the practice is more disgusting than it is harmful, though some digestive impairment is usual.

In concluding this consideration of common drug habits, let it again be accentuated that for them all moderation is necessary or harm will result; that moderately used they may be of much benefit, and that personal peculiarity will often entirely prohibit them. Let it be remembered, too, that such practices are strictly to be prohibited in childhood and early youth.

Sleep.

Sleep is the periodical and physiological rest by which Nature refreshes us when wearied. The necessity of such rest is self-evident, and the loss of it is a familiar cause of illness. The amount of sleep requisite varies with the individual, and an arbitrary

assignment of "six hours for a man, seven for a woman, and eight for a fool" is absurd. In fact, the amount of sleep we require we shall find out by experience, and, having once found it, that amount becomes the normal amount for us. As a matter of fact, the average duration of sleep of the healthy man is nearer eight hours than six.

Late hours are apt to be injurious because they are usually associated with excitement, exposure, and perhaps excess of eating and drinking; and because, in many cases, a necessarily early rising upon the following day robs the person of his normal amount of sleep. The mere lateness of the hour in itself has little to do with it, providing it is habitual for the individual to retire late, sleep his normal amount, and rise when refreshed. The habit of "early to bed and early to rise" is no doubt a good one, but late to bed and late to rise is in itself as good if regularly practised.

The taking of "cat naps" and "forty winks" is beneficial in some persons when tired, but this is largely a matter of habit and as disturbing to some as it is refreshing to others. Such naps should not be permitted after hearty eating, and should never come to act as substitutes, even in part, for the full night's sleep.

The Bowels.

It is really astonishing, as well as amusing, to see what individuality our organs possess, for they are as much creatures of habit as we ourselves. In no way is this more clearly manifested than in the action of the bowels. Once form the habit of evacuation at a certain hour, and, while health continues, at that same hour each day will the bowels move, if permitted to. It is the same with eating and sleeping, and the wisdom of forming and following such regular habits is one of the greatest protections against disease. Regularity may be carried to a ridiculous degree in unimportant occupations, and we often hear such practices referred to as fussy and foolish; but in the taking of food and exercise, the evacuation of the bowels, and in sleeping, there can be no variance or irregularity if health is to be preserved.

Exposure.

Exposure to cold and wet plays an important part in disease production, whether that exposure be habitual, as is the case in certain outdoor occupations, or whether it be occasional and unusual. The latter is, however, the more commonly injurious, and its ill effects are seen every day in the production of coughs, colds, pneumonia, sore throats, and rheumatism. Cold in itself is not so potent for harm as is dampness, but when they are combined the partnership is indeed a dangerous one. It is in climates like ours that this combination is particularly to be feared, for its action is especially noticeable where sudden changes of climatic conditions occur. To the dweller of New York city it is no rare thing to leave home early in the day lightly clad and rejoicing in a bright and temperate atmosphere, and to return home chilled by penetrating, damp, and cold winds, and perhaps drenched to

the skin. No constitution is able to accommodate itself continuously to such rapidly changing conditions, and the prevalence here of catarrhal and respiratory diseases bears evidence to this fact. Much, however, can be done to combat such injurious influences, for a gradual toughening process will make our bodies less sensitive to climatic conditions and changes. The way to accomplish this is not by keeping ourselves warmly housed and protected in our rooms—for we become weakened thereby and less resistant—veritable hot-house plants, to be chilled or killed by the first attack of cold and damp; rather should we toughen ourselves against cold and damp, and to this end the following hints will conduce: Avoid the common mistake of keeping the rooms in which you live at too high a temperature—70° Fahr. is sufficiently warm. Do not sit in the house with your overcoat or street clothing on. Sponge the throat and chest each morning with cold water. Wear woollen underclothing the year round, modifying the weight, if desired, with the season, and varying the outer clothing with the demands of the outdoor temperature. Remember, too, that draughts are far more dangerous than is an atmosphere free from draught, even if much colder; that exposure is especially dangerous when you are overheated; that far more colds are contracted from cold and wet feet than from cold and wet bodies; that thick or cork-soled shoes should be worn in cold and damp weather; and that artificial protections, such as "chest protectors," are of more harm than benefit—for, as has been well said by a physician of this city, "the best place to wear a chest protector is on the soles of the feet, and the worst is on the chest."

Protection against Exposure.

The prevalence of certain diseases suggests the adoption of special precautions, and particularly in the case of those of a contagious nature. In general, isolation, avoidance of infected rooms, houses, and districts, with disinfection, constitute the precautions, and for more detailed information the reader is referred to the article on *Hygiene*. A few diseases, indeed, there are to which specific protection may be applicable, and of these smallpox first claims consideration.

Prevention of Contagion.

The introduction of vaccination proved one of the greatest blessings to mankind, for smallpox up to that time had devastated every inhabited land. Since that time, however, the disease has become relatively infrequent, and all this we owe to vaccination. In vaccinating, the "virus" used is a fluid obtained from the blisters which form on animals suffering from a disease called "cowpox." This disease is believed to be not identical with smallpox, but the introduction of its virus into the human system serves to protect the individual from an attack of smallpox, or at least to insure his having none save a light attack. How long the protection thus acquired lasts it is impossible defi-

Vaccination.

nitely to state. The time probably varies with the individual, but in general it is considered wise to revaccinate once in seven years, and also whenever the prevalence of the disease suggests additional caution. The first vaccination is to be done in infancy.

Diphtheria Antitoxine.

It is as yet too early to speak conclusively upon the prevention of diphtheria by the use of the recently introduced diphtheria antitoxine, but, so far as present indications are to be depended on, it would seem that its effectiveness is considerable.

Cholera and Typhoid Fever.

The precautions taken to prevent cholera and typhoid fever by attention to the drinking water have already been alluded to, and it remains but to say that strict attention must be paid to intestinal disturbances, and all diarrhœas must be promptly checked, for it is in an unhealthy intestine that the germs of these diseases find their most favourable soil. To leave the districts of infection is, if possible, always to be done.

Malaria.

Malaria, too, may often be prevented, and those who live in malarious districts are wise to have their houses built upon ground as high as possible, and as far as may be from marshy ground or stagnant water, to attend carefully to the condition of their drainage, and to avoid the night air. If the residence in such places is but brief, the taking of from six to ten grains of quinine each morning after breakfast is often a trustworthy preventive.

These, then, represent, in general, the preventive means possessed by us. The avoidance of evident dangers need not be detailed, since they are not matters of medicine but of common sense. An observance of these laws will certainly conduce to a long and healthy existence, and though it is true that contagious and infectious diseases may not always be preventable, yet it must be remembered that all such diseases are far more likely to attack the unhealthy and the debilitated. The observance of hygienic laws will therefore ward off not only the organic and systemic diseases, which are usually chronic, but will in no small measure protect against the acute contagions and infections, or will, if they are contracted, render recovery from them more likely.

In conclusion, it may be said that *the preventive or prophylactic treatment of disease rests upon three essentials—regularity, moderation, and common sense.*

THE TREATMENT OF DISEASE.

If disease can not be prevented, then it must be treated, and, though it is a rule with many exceptions, in general it may be said that the tendency of all chronic diseases is to progress and increase, while the tendency of acute diseases is to recover spontaneously. Chronic disease, from its

very duration, will permit of treatment by a physician. In acute disease the inference is clear that meddling by a lay person is imprudent and dangerous. Of treatment, too little is far preferable to too much. Nothing is more deplorable than the injury of a patient by the very medicine which is intended to do him good, and therefore, in all things medical, prudence is strictly and minutely to be observed, for it is the prime requisite to safety and to success. *Two rules, therefore, are ever to be remembered: First, never to give a medicine without a very good reason for it; second, always to consult a physician when in doubt.* The importance of the latter rule is apparent and of the former scarcely less so, and yet its violation, as seen in the "dosing habit," is an every-day occurrence. The prevalence of such dosing is indeed alarming, and the habit itself is not only ludicrous but dangerous, for this constant drug nibbling interferes with and disturbs digestion, weakens resistance to disease, and so accustoms the system to the presence of the drug that when the need for it arises it no longer has power to produce an effect. The patent-medicine victim is an example of this foolish "drug habit," as is a man who, to the knowledge of the author, carries in each of his four waistcoat pockets a medicine—one for headache, one for palpitation, one for flatulence, and one for any symptom not covered by the other three.

The Drug Habit.

"To every man his own" is an excellent motto, and treatment of disease therefore belongs to the physician. This is generally recognised and granted by the laity—in fact, there are those who too frequently summon their doctor needlessly—and yet there are forms of disease which may wisely and properly be treated by those not physicians.

These are: Simple and trivial ailments; emergencies, pending the arrival of the physician; conditions requiring professional treatment and where no physician can be obtained.

THE FAMILY MEDICINE CHEST.

A family medicine chest is well enough in its way, and in default of easily obtainable medicines is indeed a necessity; but certain disadvantages are connected with its presence in the home, some of them grave ones. Thus the fact that a medicine is constantly within reach may be responsible for its too frequent administration, or its administration upon insufficient grounds. Of this practice the evil results have already been mentioned. Many fluid drugs, too, are liable to deterioration upon keeping, and if alcohol be an ingredient, evaporation also occurs, with a resulting concentration of the medicine and a consequent increase in its powers. This concentration is especially likely in the case of tinctures, and the giving of a dose of the concentrated tincture, which would have been safe and proper in the un-

Objections to the Chest.

evaporated preparation, has frequently been the cause of serious and even fatal poisoning.

If circumstances require the possession of a medicine chest, its dangerous features may be diminished and largely prevented by the observance of a few precautions. The place in which it is kept should be one which, while easily accessible, will be secure from meddlesome attacks, especially by children. It should never be locked, for a misplaced key may be the cause of serious or fatal delay. The bottles in it should be of clear white glass with smooth glass stoppers, save when they contain actively poisonous drugs, in which case bottles of blue glass with glass stoppers studded with sharply pointed projections are recommended, that by night as well as by day these peculiarities may give warning of the poisonous contents. Wooden, leather, and rubber bottle cases are manufactured, and these may well be used to protect the bottles against breaking when travelling. The label upon the bottle should be printed or clearly written, that all may read it. It should be kept spotlessly clean, and if soiled should at once be replaced. Upon the label should appear the name of the drug contained, the diseases or conditions to which it is applicable, and the dose. The stoppers must be replaced at once after using, and the greatest care must be observed that they are tightly fitted and remain so—a precaution of the utmost necessity, and especially in case the drug is a fluid.

Precautions.

Many drugs—fluid as well as solid—are now prepared as tablet triturates by thoroughly mixing them with some indifferent substance, such as sugar of milk, and then pressing into small cylindrical-shaped masses. This form of preparation is exceedingly useful, and especially when drugs must be kept long. Convenience of administration, accuracy of dosage, and safety from evaporation and deterioration are qualities sufficient to make this method of employment preferable to all others. The difficulty of administering them to children, too, is easily overcome by dissolving them in water and then giving, or by crushing them to powder and then placing on the tongue.

Tablets.

Such, then, are the pros and cons of the family medicine chest, and such the precautions necessary to its safe employment. A medicine chest is, however, but a substitute at best, and if a good pharmacy be near at hand, and therefore if drugs are readily and quickly obtainable, it is generally wiser altogether to dispense with it, for, as has aptly been said, "the best family medicine chest is a teaspoon and a drugstore."

Still, the medicine chest is often a necessity, and the contents recommended are as follows: Tablets of morphine sulphate, one eighth of a grain each. Blue bottle. Label to read: "Tablets of Morphine Sulphate, one eighth of a grain each. For pain. Dose for an adult, one tablet." Of all the drugs the chest con-

Morphine.

tains, none is to be so cautiously employed as is this, for even the laity are aware of the dangers of morphine poisoning and the dangers of forming the morphine habit, if the use of the drug be anything more than rarely occasional. Morphine will relieve any pain if given in sufficient amount, and the indication for giving is solely the severity and (the pains of labour being excepted) not at all the character or the location. The drug is to be used, therefore, in pains of such severity and duration as can not well be borne, and whose effect is manifestly injurious to the patient. For such cases, then, let one tablet be given; if no relief occur in a half hour let another be given, and similarly, and if necessary, a third and a fourth. Morphine may also be used in similar doses for sleeplessness (see *Sleeplessness*); but, unless the sleeplessness be due to pain, there are other and less harmful remedies which should invariably be tried first. For vomiting, too, a tablet may be dissolved in a teaspoonful of ice-cold water, and given thus will at times suffice to relieve. A second may be given if no benefit results from the first. One of the great objections to the use of morphine is nausea and vomiting, together with headache and depression, appearing some hours after the administration of the drug. These symptoms may sometimes be relieved by the administration of strong black coffee. The first symptoms announcing the over-effect or poisonous action of morphine are drowsiness, contracted pupils, and slowed breathing (see *Morphine Poisoning*). Morphine should never be given to children or to the aged.

Rhinitis Tablets.

Tablets rhinitis. Label to read: "Tablets Rhinitis. One half strength. (Dr. Lincoln.) For cold in the head. Dose for an adult, one every hour till throat becomes dry." The amount of suffering which a simple cold in the head can produce is known to us all, and nothing so well serves to relieve it as these tablets. They should be given in the earliest hours of the disease—as soon as sneezing, obstruction, and rawness of the nose make their appearance, for later in the disease they are less efficient, if not positively useless. Beginning, then, with one tablet every hour, we continue until the dryness of the throat informs us of the full effect of the belladonna the tablets contain. After this it is customary to give the tablets at longer intervals—usually of three or four hours—that the dryness of the throat may not become too great and yet may be maintained to a slight degree. Marked relief is generally observed within a few hours.

Aconite.

Tablets of tincture of aconite, one minim each. Blue bottle. Label to read: "Tablets. Tincture of Aconite. One minim each. For fever. For sore throat. Dose for an adult, one tablet every half hour until tongue and lips feel numb." The power of aconite to reduce fever and to diminish inflammation depends upon its action to lessen the force of the heart and to cause sweating,

for sweating will be followed by increased evaporation from the surface and consequent cooling, while both actions result in a lessening of the congestion in the inflamed areas. The drug is capable of causing dangerous poisoning, but of this it fortunately gives warning in a numbness of the lips and tongue. Upon the appearance of these symptoms, then, the giving of aconite must be stopped, and is to be resumed only upon their complete disappearance, when it may be given as before, and again suspended upon the reappearance of the numbness. In the sore throats of children and in their simple fevers aconite is of great value. In such cases one tablet may be dissolved in four teaspoonfuls of water, and one teaspoonful of this may be given every half hour until the lips and tongue become numb, if the child is old enough to notice and describe these sensations, or until the skin becomes moist and perspiring. An intermission should then be made, and a subsequent repetition of the giving if necessary. The fevers in which aconite is applicable are those of brief duration and some violence, and where the strength is well preserved. In long-continued and "low" fevers, and if exhaustion is present, as shown by a weak pulse, it will do harm.

Ipecac.

Tablets of ipecac, one tenth of a grain each. Label to read: "Tablets of Ipecac, one tenth of a grain each. For bronchitis. Dose for an adult, one tablet every hour." It may be said that some people will not recognise bronchitis when they have it; but practically by far the larger number will not fail to do so, for cough, a feeling of rawness beneath the breast bone, and a sense of oppression over the chest are symptoms with which almost all of us have become familiar by experience. If these be present, and especially if exposure to cold and wet have preceded them, the inference of bronchitis is very strong. Should nausea at any time appear while taking the ipecac tablets the drug should be suspended until this symptom passes, when the tablets may again be resumed and may be taken at longer intervals.

This treatment is not proper for children, and in them drugs are in general to be avoided; confinement to a warm room, cotton worn over the chest and back, and, if necessary, a rubbing of the chest two or three times a day with a mixture of turpentine and sweet oil—equal parts—are usually quite sufficient. If the attack be severe, however, and fever marked, in addition to these measures we may administer tincture of aconite as already described.

Aloin, Belladonna, and Podophyllin Tablets.

Tablets of aloin, belladonna, and podophyllin, compound (Fraser). Label to read: "Tablets Aloin, Belladonna, and Podophyllin Comp. For constipation. Dose for an adult, one or two tablets at bedtime." Habitual constipation is the condition for which this medication is intended, and according to the severity so will the dosage vary. Until the necessity

for a larger dose becomes apparent one tablet only should be taken, and, though it may be used if necessary each night, it is often possible to get along with a less frequent administration. (See *Constipation.*) These tablets must not be given to children.

"Sun" Cholera Tablets.

Tablets of "sun" cholera mixture (Fraser). Label to read: "Tablets Sun Cholera Mixture. For diarrhœa. Dose for an adult, one tablet." The "sun" cholera mixture has for many years enjoyed a great reputation in the treatment of cholera morbus and diarrhœas. These tablets contain the same ingredients as do the mixture, and four of them represent the equivalent of one teaspoonful of the mixture. They should be given at intervals of a few minutes until three have been taken; thereafter one may be given after each movement of the bowels. As they contain capsicum (red pepper), they must be quickly swallowed, and, to prevent irritation of the stomach, a drink of hot water should follow; or they may be taken dissolved in hot water. They contain opium, too, and hence the necessity for frequent administration should make us careful to observe the possible evidence of opium poisoning, in the presence of which the medicine must at once be stopped. These tablets must not be given to children.

Dover's Powder.

Tablets of Dover's powder, one grain and a quarter each. Label to read: "Tablets of Dover's Powder, one grain and a quarter each. For diarrhœa. To cause sweating. Dose for an adult, one to eight tablets." Dover's powder also contains opium, and on its presence the value of the preparation in diarrhœa depends. According to the severity of the diarrhœa, the dose will range from one to two tablets, given every two or three hours. The signs of opium's overeffect must be watched for in giving this preparation.

It is common knowledge that if a person takes a cold and within the first few hours thereafter has a thorough "sweat," he is likely to "break up" his cold. For the production of such a sweat there is nothing so useful as one full dose of Dover's powder. For such cases the dose is eight tablets, taken as one dose, and to increase and augment the sweating the patient should be warmly covered in bed and take hot drinks freely. The sweating thus induced is usually profuse, and when it has reached a sufficient amount, and its continuance might induce weakness, it is to be terminated by rubbing the patient vigorously with rough towels until dry and then changing his bedclothing, with the application of a lesser amount of covering. Exposure to draught and cold must be carefully avoided, since there is an especial danger of taking cold when sweating. Dover's powder is not to be given to children.

Tablets of calomel, one tenth of a grain each. Label to read: "Tablets of Calomel, one tenth of a grain each. To purge. Dose for an adult, one tablet every half hour." Calomel is to be used when a free open-

ing of the bowels is desired, occasionally only, and not frequently or for habitual constipation, as are the aloin, belladonna, and podophyllin tablets of which we have spoken. Curiously enough, diarrhœa is as often benefited by calomel as is constipation, and for the reason that diarrhœa is often an evidence of Nature's attempt to free the body from irritating and indigestible food, the retention of which in the intestines would do harm. If, then, calomel be given to such a case, Nature is aided in ridding the body of the unhealthful matter, and the intestine being emptied, the diarrhœa ceases. Any diarrhœa associated with much flatulence and discomfort in the abdomen (the evidence of fermentation) may wisely be so treated. Such a condition is often seen in those people called "bilious," and is apt to alternate with a condition of constipation. For such patients no treatment is so desirable as an occasional calomel purgation. Constipation is an evidence of the inability of the intestine to empty itself, and, if occasional only, may well be relieved by calomel. A free purging will often be beneficial at the beginning of an acute feverish attack, in the same manner as is a free sweating, and for this object calomel is excellent. To produce purgation by these calomel tablets let one be taken every half hour until the bowels have moved freely or until ten have been taken. As a rule, ten tablets will be required. If no movement has occurred six hours after the last tablet has been taken, a dose of salts should be given. The variety of salts is unimportant, and Epsom salts, Rochelle salts (in tablespoonful dose repeated once if necessary), or a wineglass of Hunyadi water are equally applicable, for it is necessary only that the assistant purgative be a saline. Calomel is best given on an empty stomach, and usually, though not necessarily, just previous to retiring. In the fermentative diarrhœa of young children, in which flatulence and foul-smelling movements occur and with which vomiting may be present, calomel is a most effective remedy, and one of the tablets may be given every three or four hours, according to age and necessity. The vomiting, too, is relieved by the drug.

Calomel.

Pills of quinine sulphate, two grains each. Label to read: "Pills of Quinine Sulphate, two grains each. For chills and fever. As a tonic. Dose for an adult, one to five pills." Quinine is a direct poison to the micro-organism which causes malaria; this has been determined beyond all question. The administration of the drug for the treatment of malaria is therefore eminently proper and rational. For well-marked chills and fever three of the pills should be given three times a day, unless buzzing in the ears and headache are produced, in which case a few doses are to be omitted, and thenceforth the dose may be reduced to two pills. This dosage is continued until the symptoms have been gone several days, when a gradual reduction of the dose may be made. This reduction, however, should be a matter of two

Quinine.

or three weeks, for a sudden cessation of the drug is not infrequently followed by a reappearance of the symptoms.

So much for true "chills and fever," which occurs in attacks at the same time every day, or every second (rarely every third) day, the attacks being marked by chill, fever, and sweating in regular sequence; but malarial poisoning manifests itself in other and less characteristic symptoms. Thus each day there may be slight fever, headache, indigestion, or general discomfort. The main point is that, as a rule, these disturbances, if malarial, occur at the same time on each day. Less vigorous treatment will suffice in such cases, doses of two or even one of the pills being generally sufficient. The recognition of the malarial disturbances will generally be more easy to those who have previously been sufferers, or to those whose residence in malarious localities entitles them to the disease. It is the fashion, however, to describe as malarial every ache and pain from which a patient may suffer, providing there be no more evident reason for the illness. The name malaria has therefore become a sort of medical "charity," since it certainly is made to cover a multitude of diagnostic sins. Fortunately this error, though foolish and unscientific, is usually not productive of much harm, for quinine is a valuable bitter tonic, applicable in cases not malarial. For children the dose of quinine is from one to two grains, according to age. In all malarial diseases it is of great advantage to begin the treatment by a free purgation, preferably by calomel. Quinine, too, is valuable in preventing malarial infection. (See *The Prevention of Disease.*)

Compound Cathartic Pills.

Compound cathartic pills. Label to read: "Compound Cathartic Pills. For constipation. Dose for an adult, two at bedtime." For the correction of *occasionally occurring* constipation there is nothing more trustworthy and efficient than these pills. They are reliable in action, thorough and agreeable. Taken upon going to bed, they in no way interfere with a good night's sleep, and their action is usually seen early upon the following morning. *They are not to be given to children, and are not suitable for any save an occasional use.*

Sodium Bicarbonate.

Tablets of sodium bicarbonate, ten grains each. Label to read: "Tablets of Sodium Bicarbonate, ten grains each. For acidity and heartburn. Dose for an adult, one tablet." This sodium bicarbonate, or "bicarbonate of soda," is the cooking soda (not baking powder and not washing soda) used in our kitchens. It might be kept in the medicine chest in powder instead of in tablet, for the latter form is to be preferred only on account of convenience in handling and in the measurement of dosage. The drug is, however, practically harmless, and if kept in powder may be administered in dose of a quarter of a teaspoonful dissolved in water. The tablets

may be swallowed whole and followed by a drink of water, but a more satisfactory method of administration is to give them dissolved in water. The dose may be repeated, if necessary, in two hours. Repeated doses are often beneficial in rheumatism.

Boracic or Boric Acid.

Tablets of boracic acid, five grains each. Blue bottle. Label to read: "Tablets of Boracic Acid, five grains each. For external use." Though its chief value is in external application, internally the drug is harmless, in *moderate* amounts, and therefore it is to be kept in a blue bottle, rather to call attention to its being intended for external application than from any danger likely to result from the swallowing of several tablets. The use of boracic acid in solution is as a soothing and healing application to mucous membranes and delicate structures. For red and bloodshot eyes, with burning, smarting, and watering, whether in adults or in children, nothing is so good as to dissolve one of the tablets in a tablespoonful of warm water, and then to drop the solution into the eye by means of a medicine dropper. This may be done twice or three times a day, according to the severity of the case, when improvement will soon result. In the sore mouth seen especially in children, when it is apt to accompany teething or indigestion, and to which the names of "sprue" and "thrush" are sometimes applied, boracic acid is very healing. For use in such cases two tablets may be dissolved in a tablespoonful and a half of warm water, and the solution used in washing out the mouth at intervals of two hours and, in particular, after feeding. The addition of an amount of glycerin equal to the amount of water used makes the solution even more healing, and such a mixture is much to be preferred to the familiar "borax and honey."

Sodium Bromide.

Tablets of sodium bromide, five grains each. Label to read: "Tablets of Sodium Bromide, five grains each. For sleeplessness, for convulsions. Dose for an adult, three tablets." Sodium bromide, or bromide of sodium (often incorrectly called "bromide of soda"), may be employed to produce sleep when the other and simpler remedies spoken of elsewhere (see *Sleeplessness*) are inefficient. The dose is three tablets followed by a drink of water. The dose may be repeated in an hour, if necessary. No drug is so useful in stopping and preventing convulsions as is bromide of sodium; it is therefore the drug regularly used in the treatment of epilepsy; but this disease, being chronic, will permit of professional attention, and its treatment should not be attempted in the family save when an attack requires relief (see *Epilepsy*). Convulsions in children are due to many causes, and a consideration of these will be given later. The cause, if possible, will of course be removed, but to quiet the attack and to prevent its recurrence bromide of sodium should be employed. Of this the appropriate dose for a child one year old is two grains, which may be repeated in two hours if

necessary. The two-grain dose may be made by dissolving one of the five-grain tablets in water and then administering two fifths of the solution.

Turpentine.

Spirits of turpentine. Blue bottle. Label to read: "Spirits of Turpentine. For external use." Turpentine swallowed is a dangerous poison, and its internal use should never be allowed save under the direction of a physician. Externally it is valuable to produce counter-irritation by means of liniments and stupes. Combined with an equal quantity of sweet oil, it makes an excellent liniment to rub on the chest in bronchitis (for children, also, this is not too strong), and a turpentine stupe is very effective for abdominal pain and colic (see *Stupes*).

Alcohol.

Alcohol (ninety-five per cent.). Label to read: "Alcohol. For external use." Alcohol may indeed be used as a substitute for whiskey or brandy when these can not be obtained, but if so used it must be given in half their dose and freely diluted with water. Its main use is for the alcohol rub, a procedure most restful in lameness, muscular soreness, and fatigue. Diluted with an equal quantity of warm water, it may be used for the alcohol sponge bath, an application most soothing in nervousness and sleeplessness, and valuable, too, in slightly reducing the temperature of fever. In giving the bath, one part of the body at a time is to be sponged, dried, and covered by the bedclothes, until by parts the whole body has been treated. It is exceedingly refreshing and grateful to patients, and may be repeated at frequent intervals, and is suitable to use for children as well as for adults.

Castor Oil.

Castor oil. Label to read: "Castor Oil. To move the bowels. Dose for an adult, one or two tablespoonfuls. Dose for a child, ten drops to a teaspoonful." The cases in which castor oil is suitable are the same as those treated by calomel, but while calomel is to be preferred for adults, castor oil is by all means the purge for children. For a child a few weeks old the dose of castor oil is ten drops. The amount to be given increases with the age, until a teaspoonful may be given when the age of one year is reached. Its action is usually prompt and thorough, but its after-effect is often to cause constipation (hence its double value in diarrhœa), and it is apt to gripe. This griping may be prevented in a child over six months old, by adding to each dose five drops of paregoric. Children younger than this should not be given paregoric.

Whiskey.

Whiskey. Label to read: "Whiskey. For stimulation. Dose for an adult, one tablespoonful." All conditions in which the circulation is weakened call for the administration of stimulants. Of these, the most generally useful is whiskey, though brandy is little less desirable and may be used as a substitute for it. Its action is increased and hastened by administering it mixed with hot water. The conditions in which it is most valuable are fainting, shock, drowning, ex-

hausting illness, exposure, chill, and, in general, where the pulse is rapid and weak. Its continued use must never be permitted, save under the direction of a physician, lest thereby a habit be established.

The Thermometer.

In addition to these drugs there are certain medical appliances which may wisely be kept in the household, since they are likely to be required from time to time, and when needed must be had promptly. First of all is the thermometer. The usefulness of the thermometer is self-evident, and no arguments in its favour or details of its applicability are required. The form needed is the so-called "clinical thermometer," and should be self-registering. Of such thermometers, that manufactured by Hicks is undoubtedly the best.

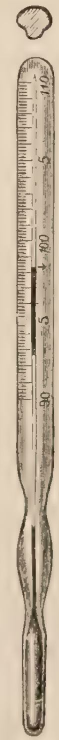


FIG. 1.—HICKS'S CLINICAL THERMOMETER.

Method of taking the Temperature.

The method of taking the temperature is as follows: First shake the column of mercury within the thermometer down below the point of normal temperature (98·4° Fahr.). This point is indicated by an arrow engraved upon the glass. Place the bulb containing the mercury beneath the tongue and have the patient firmly close the lips, but not the teeth. Allow the thermometer to remain thus five minutes, then remove it and read the amount of temperature registered. Wash the thermometer in cold water, since, if hot water is used, the mercury contained is expanded beyond the capacity of the thermometer and the glass is broken. The temperature in health varies, within certain limits, at various times of the day, and is affected by transient and unimportant causes. Thus temperatures slightly less or slightly greater than 98·4° Fahr. are not in themselves indicative of disease. As a rule, a temperature under 100° Fahr. is not to be considered febrile. Instead of taking the temperature by the mouth it may be taken in the axilla, or armpit, by placing the bulb within the hollow, bringing the elbow of that side firmly against the chest, and placing the hand across to the other side of the chest. The axilla thus becomes practically within the body, and the temperature thus taken, though usually about half a degree lower than the mouth temperature, is sufficiently indicative of the body temperature to be useful. This method is exceedingly valuable when a difficulty in breathing or a state of unconsciousness makes it impossible to keep the lips closed. In young children it is customary to take the temperature by slightly greasing the bulb of the thermometer and inserting it in the rectum, where, as in the case of the mouth and the axilla, it is to be retained for five minutes. Exceptionally, this method is employed for adults.

The temperature taken thus is usually about half a degree higher than the mouth temperature.

Mustard Leaves.

Prepared mustard leaves are exceedingly useful for the traveller, but are in no way so useful in the family as are well-made mustard pastes, since they are of uniform strength, and, though cloth of varying thickness placed between them and the skin will to varying degrees lessen their action, yet is this action seldom so efficient as is that of the old-fashioned mustard plaster. These prepared mustard leaves come in tin boxes which, if kept tightly closed, will preserve their strength. When dipped in warm water the leaf at once becomes ready for application. The home-made mustard plaster will receive consideration hereafter.

Hot-water Bag.

A hot-water bag, of three quarts' capacity, should be kept in every household. Beside the drugs and apparatus which may wisely be kept in the house, because not otherwise quickly obtainable, there are others, the use of which by the laity is reasonable and proper, but which, because not necessary in emergencies and because many of them deteriorate on keeping, are not to be included in the family medicine closet. No extended consideration will be given to these, because their applications are not generally to emergencies, and therefore, the saving of time being less an object, there will be opportunity for consulting a physician; and this, let it be emphasized again, should always be done when possible and save in the slightest and mildest of disturbances.

Stimulating Liniment.

"Stimulating Liniment." A well-known hospital of New York city has in its formulary a liniment bearing this name. It is applied in conditions of soreness, lameness, muscular stiffness, and pain *not accompanied by any evidence of inflammation or by a broken skin.* For such conditions as muscular rheumatism, lumbago, stiffness, long-continued lameness, rheumatism, and pleurisy (when not acute), a weak, stiff, or painful joint, if no active inflammation be present, it is often beneficial. It is to be rubbed on twice a day, at first gently, later more vigorously, the object being to produce moderate redness of the skin. No pain should be caused by its application, and if pain appear, the rubbing should at once be stopped. If it be used upon an extremity, the rubbing should be away from the hand or foot and in the direction of the body. When the skin has become well reddened the rubbing should be stopped and the part protected against cold by wrapping it in cotton or in flannel. The composition of the liniment is—

Tincture of capsicum	1 ounce.
Ammonia water	1 "
Soap liniment	2 ounces.

Mix them and let the label read: "For external use only."

This liniment is too strong, as a rule, for young children, and for them the mixture of equal parts of turpentine and sweet oil already referred to will take its place.

Syrup of Ipecac.

Syrup of ipecac is the best emetic for use in young children. Its dose is half a teaspoonful, administered every fifteen minutes until vomiting occurs. If four doses have been given, however, and no vomiting has occurred, it is wiser then to cease its administration and resort to the other emetic procedures spoken of under *Vomiting.* For older children the dose is a teaspoonful administered in a similar way, and for adults the dose is a tablespoonful. Syrup of ipecac is so useful and valuable in emergencies that it might well be added to the family medicine chest; and indeed it may be so added, if occasionally it be replaced by a fresh supply, for considerable time must elapse before deterioration is sufficient to influence the action, and, if well corked, it is not liable to dangerous concentration. To cause the emptying of an overloaded stomach or one which contains irritating or poisonous materials; to check vomiting by hastening the thorough emptying of the stomach; to expel the mucus from the windpipe and lungs, when much rattling in the throat indicates its presence, and the child shows inability to clear the throat by feeble and ineffectual coughing; as well as to terminate an attack of spasmodic croup, are the occasions for its administration.

Brown Mixture.

Brown mixture is a cough mixture of much value in the early days of a cold upon the chest, when the cough is tight and harassing and the oppression of the chest is great. In marked hoarseness, too, which often is the result of such a severe "cold," it is one of our best medicines. In both these cases its early administration, combined with confinement to a warm room, careful protection of the chest and throat, a thorough movement of the bowels, and perhaps the rubbing of the chest and throat with one of the liniments already mentioned, will in a very short space of time produce relief from all distressing symptoms and a softening and loosening of the cough, which with the continued use of the mixture will soon disappear. The mixture alone, indeed, will cure those cases in which the symptoms are but slight. Brown mixture is also known to apothecaries under the name of compound licorice mixture, and is exceedingly pleasant, as medicines go, to the taste. Its dose for an adult is a teaspoonful every three hours; for a child, half that amount. It is not to be used for infants.

Aromatic Spirit of Ammonia.

Aromatic spirit of ammonia is given for a weak pulse, and especially for fainting conditions. For these purposes the dose is half a teaspoonful in water, and this dose may be repeated in half an hour if necessary. Aromatic spirit of ammonia may be continued in this dosage every three hours, but if a

weakened circulation or fainting last so long as to make repeated medication necessary, it is clearly an indication for the summoning of a physician. Fifteen drops of the spirit may be given in water to an adult when an acid condition of the stomach is shown to exist by the presence of flatulence and heartburn, and used then will often give relief from these symptoms.

Paregoric.

Paregoric is a tincture of opium with camphor, and is also known under the name of the camphorated tincture of opium. Like all opium preparations, it is to be used with caution, and a careful watch kept of the eyes and the breathing that poisoning does not result. Paregoric is probably more abused than is any other medicine, and the practice of giving it indiscriminately to children, as is the case, can not be too strongly condemned. That the child who cries is at once to be dosed with the ever-handy paregoric seems to be the guiding principle of many women, and to them it makes little difference whether the cause of the crying be colic, temper, thirst, a pin misplaced, or serious illness; for they have the quieting remedy at hand, so in it goes. More than once has it happened to the writer to have a mother bring her child to him in a condition of stupor, the cause of which was the paregoric administered for crying, and a glance at the pupils of pinpoint size has shown the condition to be one of opium poisoning. That such treatment is not more often fatal is remarkable when the extent of the practice is known, and when it is realized that children bear all opium preparations badly. That children are often benefited by paregoric is not denied, but carelessness in its use is harmful and dangerous in the extreme. If a child cries there is always a reason for it, and if that reason be not soon apparent, and if the crying persist, then the physician should be consulted; for the ready alternative paregoric can not cure indigestion, or earache, or tooth-cutting, or serious disease. And so, while its occasional use for the *relief* of pain is allowable, it must never be employed save occasionally and most cautiously, and never to the neglect or exclusion of remedies calculated to *cure*. In colic, paregoric is often of benefit, but so is the harmless peppermint water, and yet more is attention to the proper diet, and the time and method of feeding. In diarrhœa, too, it will often check the discharge, but a safer and more rational remedy usually is castor oil. In restlessness and sleeplessness of acute disease paregoric is quieting and sleep-producing, but so is the safer sodium bromide. One serious disadvantage of paregoric is a power to disturb digestion, which is possessed by all opium preparations. The occasional and moderate use of this preparation is, however, not objectionable, and, if used, a safe dose for a child a year old is five drops, while a child of two years may take ten. Paregoric is not often used by adults, but occasionally it is given for diarrhœa, when its dose is one or two teaspoonfuls.

Peppermint Water. Peppermint water has, as already stated, an excellent effect in flatulence and colic in children, and for this purpose it may be given in doses of a half to one teaspoonful in warm water and repeated as often as necessary.

Limewater. Limewater is beneficial in conditions of indigestion associated with vomiting. For adults it is usually given with milk in proportions varying from one eighth the quantity of milk to one half. Such a mixture, if taken at intervals in teaspoonful doses and very cold, will often allay the vomiting, after which the intervals may be shortened and the doses increased in size. In bottle-fed children the vomiting of milk in large curds will often be relieved by the addition to each bottle of a tablespoonful of limewater. As an external application limewater is sometimes used mixed with an equal quantity of olive oil (the mixture being known as "Carron oil"), for application to burns. (See *Surgical Injuries and Surgical Diseases.*)

Tincture of Iodine. Tincture of iodine. Deep-seated pains, muscular soreness and stiffness, chronically lamed and stiffened joints, are sometimes benefited by painting the affected area with tincture of iodine. In using it, the tincture is to be painted on (in the cases of adults) until the skin is stained a deep brown. At the end of twenty-four hours this will have faded, when the colour may be reproduced by painting on a few additional coats of the tincture. This treatment is to be persisted in until the skin over the area treated begins to peel off. In children the iodine must be less generously applied, the skin must not be so deeply stained, and in them two or three coats are usually sufficient. The applications of tincture of iodine, then, are practically those in which the "stimulating liniment" are useful, and in practice sometimes one will work the better, and sometimes the other. In general the iodine will be more applicable in cases where the rubbing would cause pain. Like the liniment, too, the tincture of iodine is not to be painted over actively inflamed areas or over denuded surfaces. If the iodine bottle is to be kept for any time in the house it should be carefully labeled, "For external use only."

Lead and Opium Lotion. Lead and opium lotion is an application useful in bruises, contusions, and sprains. It is to be kept applied to the injured part on cloths wrung out in it and arranged, not thickly, so that evaporation may be freely allowed. (See *Surgical Injuries and Surgical Diseases.*) It is to be used for external application only. Its formula is as follows:

Solution of subacetate of lead..................	1 ounce;
Tincture of opium...........................	½ "
Water enough to make........................	1 pint.

Mix.

Dobell's solution is a cleansing and healing solution much used by specialists in diseases of the throat and nose. It may be used as a gargle in slight inflammations of the throat, but is more effectively applied in spray and by the atomizer. In catarrhs it may well be sprayed into one nostril, and, the head being well held back, the solution will pass completely through the nose to the throat. The head being then bent forward, the solution will run from the nostril of the other side as well as from the one sprayed. Several attempts may, however, be necessary before the passages are made sufficiently clear for this action, and in the more serious conditions of nasal stoppage it may not occur at all. Under these circumstances the physician or specialist must be consulted. In blowing the nose after a spraying but one nostril should be blown at a time, the other being stopped by pressure of the finger. The neglect of this precaution may be followed by forcing dirt from the throat into the passage connecting it with the ear, when inflammation of the ear may result. If in spraying thus a little of the fluid be swallowed no harm will result, though the solution is not to be taken internally. This spraying may be done once or twice a day, and in case the fluid burns or irritates the nose or throat too much, it may be diluted with an equal quantity of water. This is especially to be done in case the patients are children.

Dobell's Solution.

Coffee is not only a drink and a beverage, but is a drug and a medicine. Its function is to arouse and excite nerve action, and particularly the action of the brain. For this reason it is useful in conditions of exhaustion, fatigue, overwork, and debility in general. It will produce wakefulness, too, but its continued use to avert a natural desire to sleep is unhealthful and injurious. It is more active if given strong and without milk. In opium poisoning it is one of the best means we possess to arouse and awaken the patient, and should be given freely. This is not the place for a consideration of coffee as a beverage, and beyond the statement that its use is forbidden in youth, nervousness, most diseases of the heart, some forms of indigestion, and, generally, the bilious tendency, nothing will be said.

Coffee.

Tincture of ginger is to the flatulent adult what peppermint water is to the colicky child, and fifteen or twenty drops taken in a cup of hot water will generally be followed by relief. The dose may be repeated if necessary every hour. In those who misuse and abuse alcohol, similar doses given three times a day and before eating will often restore tone to the stomach and relieve the loss of appetite, nausea, and even vomiting, from which these unfortunates so often suffer.

Tincture of Ginger.

Chlorate of potassium (commonly called chlorate of potash), though at times prescribed by physicians for internal administration, should never

be so used by the laity, since the drug is capable of causing a most dangerous poisoning. It is in the simple forms of tonsilitis and sore throat that, used in solution and as a gargle, it is applicable in domestic practice. The solution appropriate for this employment is made by dissolving a teaspoonful of the drug in half a tumbler of water. It should be used every two or three hours, and there is some advantage in using it very cold. Though poisonous in large doses, the accidental swallowing of a little of the fluid in gargling need not cause alarm.

Chlorate of Potassium.

Phenacetine powders, five grains each. Phenacetine is one of the newer drugs, and is used to relieve headache, rheumatic and neuralgic pains, and to reduce fever. For these purposes it is very efficient, and its use is generally unattended with danger. It will sometimes cause profuse sweating and rarely some weakening of the circulation, but this almost never reaches a dangerous degree. In these respects it differs from antipyrine, which is much used by the laity for the relief of similar painful and febrile symptoms, for whereas phenacetine is practically harmless, antipyrine is an exceedingly dangerous drug. The popularity as well as the dangers of antipyrine suggest a few words on that drug, and though a digression, the importance of the subject will excuse it. The danger of using antipyrine lies especially in its treachery, for while in some persons it will act safely and well, in others it will, without the slightest apparent reason, cause fainting, sweating, prostration, weakened circulation, collapse, and even death, and these, too, after doses exceedingly small. For these reasons the popular use of antipyrine is in every way unsafe. If phenacetine is given to reduce fever and to diminish the painful and lame feelings associated with it, the dose for an adult is five grains every three or four hours, according to necessity. In such cases it works admirably, and the cooling and comforting alcohol bath may wisely be used in connection with it, the results being soon apparent in the comfort of the patient and frequently in refreshing sleep. For rheumatic pains similar dosage is allowable, but for severe headache and neuralgia more of the drug will, as a rule, be needed, and it is customary to give five grains of the powder every half hour until three doses have been taken, unless the pain shall have ceased before that time. Subsequently the five-grain dose may be administered at intervals of three or four hours, if the pain returns. As phenacetine is not soluble in water it is generally given dry upon the tongue and then washed down by a sip of water, and as it is tasteless, no difficulty will be met in taking it thus. It may, if preferred, be taken in compressed tablets (five grains each), but if these are used they should be bitten or broken into fragments before swallowing, to insure their rapid and complete absorption. Though sometimes given to chil-

Phenacetine and Antipyrine.

dren in doses of from one to two grains, according to age, this use of the drug is more safely intrusted to the physician.

Ichthyol Ointment.

Ichthyol ointment (five per cent.). Ichthyol also is a recently introduced drug and is prepared from a bituminous substance containing fossil fishes and found in the Tyrol. It is possessed of a powerful odour, and to those who once smell it no possible doubt can occur as to the entire truth of the "fish story." However, we may well forgive it for a characteristic that is "the only fault in an otherwise perfect character." In bruises, in sprains, in "water on the knee," or "water" on any other joint, in old joint injuries, where from time to time slight pain and stiffness recur, in slight inflammations of the skin, as in the moderate grades of burns and scalds, in ivy poisoning and stings, there is nothing which so promptly, so permanently, and so easily causes relief and cure as ichthyol. For such cases the severity will determine the strength of the application, but as a rule a five-per-cent. ointment will be suitable and harmless in them all. Let the ointment be made by having the apothecary thoroughly mix twenty-five grains of ichthyol with one ounce of ointment of zinc oxide. Let the label read: "Ichthyol Ointment, five per cent.," and in using let the salve be smeared thickly over the affected part and a snug-fitting bandage applied. Of the conditions thus treated, more complete information will be found in the chapters on *Surgery;* our consideration is not of the diseases, but of the drug.

Vaseline.

Vaseline. It seems scarcely necessary to do more than to mention the name of vaseline to have the subject thoroughly understood, for its use is so common in every household, and its applications are so many, that the housewife is indeed more familiar with it than is the physician, and hence is more competent to speak. To protect, to soothe, and to heal are its functions in disease, and, if fresh and clean and uncontaminated, it can do no harm wherever applied, save only in open wounds.

Blaud's Pills.

Blaud's pills. Though we so often hear the expression, "I think I need a tonic," made by those who are in riotous good health, or at most are suffering from nothing more severe than overeating, or oversmoking, or overexcitement, and though a "tonic," in the popular mind, means any medicine which tastes bad, still, of all those who think they need a tonic a small proportion really do. Now a tonic is something which, regardless of colour, smell, or taste, makes strength, and one of the best of these is iron. There are many preparations of iron, but among them all there is none more convenient or better than Blaud's pills. These are prepared in several sizes, but the most practical is the five-grain pill. Now, there are other tonics besides iron, and of those who really need tonics not all need iron. For these reasons, then, and particularly because time will always permit of obtaining a pro-

fessional opinion, tonic treatment should be left to the physician. And yet an understanding of the tonic application of iron will not be out of place, and the facts are as follows: The blood contains iron—in fact, iron is its most important mineral ingredient. From time to time the iron in the blood, from one cause and another (sometimes it is disease, sometimes overwork, and sometimes the cause is unknown), becomes lessened in amount, and the condition of impoverished or "watery" blood thus established is called anæmia. The rosy hue of health is dependent upon the richness of the blood in iron, and one of the most striking appearances of anæmia is pallor. Pallor, however, is not necessarily indicative of anæmia, for many are habitually pale whose blood is normal in every respect, and a high colour, too, is consistent with a considerable anæmia. While this is true of the skin, however, it is usually not true of the mucous membranes, and a glance at the colour of the tongue will in general be a safer guide than the colour of the skin. In anæmia the tongue is pale. More reliable information still is at the hand of the physician in an examination of the blood itself; but this is technical and beyond the laity. Practically, however, the tongue is pale in anæmia. To restore to the blood its lost iron is the object of treatment, and so the various forms of iron are given internally, that being absorbed by the blood they may thus accomplish this object. As has been said, Blaud's pills are among the best of iron preparations and are given usually in doses of one or two pills three times a day, after eating, until, with the return of colour to the tongue and of vigour to the patient, they are no longer needed. During the administration of iron it is of great importance that the bowels remain regularly open, for constipation interferes with the desired absorption of the iron.

Iron.

"Salts" scarcely need a definition; all are familiar with their object; but, strictly speaking, the term salts includes far more than substances which taste salty and move the bowels; yet the more scientific name, saline cathartics, scarcely adds to their effectiveness, and whether they are called by this name or called "salts" will make but little difference in their action on the bowels. The saline cathartics in general use include Epsom salt, Glauber's salt, Rochelle salt, Carlsbad salt, Seidlitz powder, and "citrate of magnesia." Their use is to move the bowels thoroughly and promptly, and, as has already been said, they have a special usefulness in increasing and completing the action of calomel. They differ somewhat in their applications, and a brief consideration of the members of the group will therefore not be amiss.

Salts.

Epsom, Glauber's, and Rochelle salts are for occasional use only—when it is desired to sweep thoroughly and clean the digestive canal. They are not intended for continued use in habitual constipation, for in such a case they would, as a rule, be weakening and injurious. They have the dis-

advantages of being very disagreeable to the taste and of causing griping. For an adult the dose is a tablespoonful, or even two tablespoonfuls, though the latter dose would often be unnecessarily energetic. They are given dissolved in water, and the less the water administered with them the more will be abstracted from the body by them, for water they must have in order to act. For this reason they are given in the first hours of acute inflammatory disease, and in very little water, that they may abstract water from the body, in the fluid movements they cause, and thus may diminish the congestion in the inflamed area. A better way of administering them is to give the selected salt in dose of a teaspoonful, dissolved in water, every hour until the bowels have moved freely, or until six or even eight doses have been taken. Given thus they are quite as effective as in the other form of administration, and even more so, for the amount necessary may more easily be judged, overdosing is less likely, and griping is less severe. Similarly, they may be given to children over twelve, in teaspoonful doses every hour until three have been taken.

Carlsbad salts, on the other hand, are generally employed for the habitual constipation associated with the "bilious," the plethoric, and the gouty tendencies. They are to be taken dissolved in a glass of hot water each morning and before breakfast, the dose usually being between one half and one teaspoonful, depending upon the effect upon the patient. The end sought is to produce one or two movements during the morning, and the dose necessary will vary with the individual. These salts are not given to children, and their continued use for adults is only for the strong and the robust.

Seidlitz powders and "citrate of magnesia" offer marked advantages over the "salts" of the first group, since they are not disagreeable to the taste and are of a milder action. Otherwise their employments are the same. The Seidlitz powders come in boxes containing a number of powders, of which half are wrapped in blue papers, the other half in white. In using the medicine we dissolve the contents of a white paper in a third of a tumbler of water and the contents of a blue paper in another; we then mix the two solutions and, effervescence resulting, we drink the mixture "while it bubbles." "Citrate of magnesia" is a fluid preparation, and a half bottle is drunken as a dose, the other half being taken in about two hours if the first dose has not been effectual. This "citrate of magnesia" (its proper name is the solution of magnesium citrate) is an excellent cathartic for children of ten and over, for it is mild, and, moreover, it tastes like lemonade. For such a child the dose is a claret-glassful, repeated in two hours if necessary.

All cathartic medicines are to be given, when possible, upon an empty stomach, and the salines in particular are to be so administered, else they are likely to prove unreliable or inactive. As a rule, saline cathartics are

to be given only to the strong and vigorous, for in the weak and feeble they are apt to exhaust, especially if given frequently or in large doses. They have an especial value in the gouty and rheumatic, and in attacks of rheumatism and gout are a valuable part of the treatment.

Rhubarb- and Soda-Mixture.

"Rhubarb and soda mixture" may be obtained at all pharmacies, and is especially of value in dyspeptic conditions traceable to improper food, whether in the case of adults or of children. If, therefore, the breath becomes offensive and the tongue slightly coated, if distress occurs in the stomach after eating, and wind and heartburn be complained of, a properly regulated diet, with the administration of rhubarb and soda mixture, before each meal will usually, and in a few days, result in relief and cure. The dose of this preparation for an adult is a tablespoonful, and for a child a half to one teaspoonful, taken in water.

Oxygen.

Oxygen, as all know, is contained in the air we breathe, and is the life-supporting element in the atmosphere. In certain diseases, such as pneumonia, the absorption of oxygen by the lungs is interfered with, and as a consequence the patients become "blue in the face," or, as it is technically called, cyanotic. Hence the belief arose that if the air the patient breathed were made to contain more than the usual amount of oxygen, he would get a sufficiency of it into his body in spite of the fact that his lungs were not working normally, and so oxygen came to be given by inhalation. This remedy is one which would hardly be used save under the direction of a physician, for a state so grave as to require oxygen inhalations would certainly require a physician if one could be had. No harm would result from its administration by the non-professional, however, for the gas is harmless. It can be obtained in all large cities from those who make it, and the addresses of these can be obtained at any pharmacy. The gas comes in iron cylinders, and with them comes the tubing and apparatus necessary for the inhalation process. In cases of moderate severity the gas may be inhaled for a few minutes every hour or every half hour, while very severe cases may require the playing

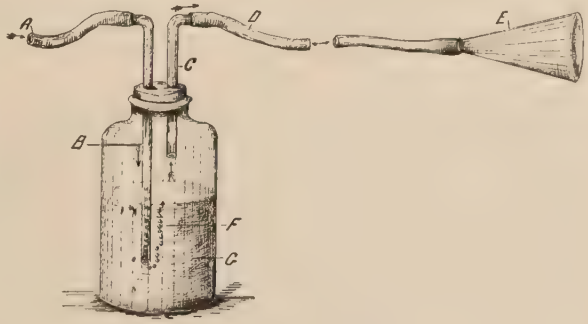


FIG. 2.—AN OXYGEN FLASK.

A and *B*, pipe and tube respectively conducting the oxygen from the cylinder into the flask; *C* and *D*, tube and pipe conducting the oxygen from the flask to the patient; *E*, inhaler; *F*, bubbles of oxygen; *G*, water.

of the stream of oxygen constantly across the lips of the patient. The indications for the administration are, as we have said, cyanosis and difficulty of breathing from any cause, and if the remedy is efficient, the evidence is soon seen in a disappearance of the lividity and a return of the healthful colour.

There are certain mechanical devices which are very useful in lay hands; and though they are not, many of them, strictly speaking, necessary, yet they are often great conveniences. The atomizer is one of these, and an important one, its use in the employment of Dobell's solution having already been mentioned. The

Atomizers.

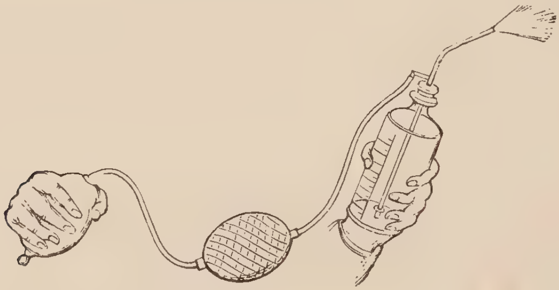


Fig. 3.—An atomizer.

proper kind is one which works by pressure of the hand bulb, all steam-spray apparatus being much too complicated and likely to get out of order.

The Croup Kettle.

The croup kettle is simply a tin kettle placed on a stand over an alcohol lamp. From the cover of the kettle projects a long tin spout. In use the kettle is filled half full of water, the lamp is lighted, and the column of steam pouring from the spout is directed toward the mouth of the patient, that the warm, moist air inhaled may exert its soothing effect upon the inflamed throat and windpipe. Care must be exercised, however, that the spout is not placed too near the patient's mouth, for if *hot* steam is inhaled it is as irritating as *warm* steam is soothing.

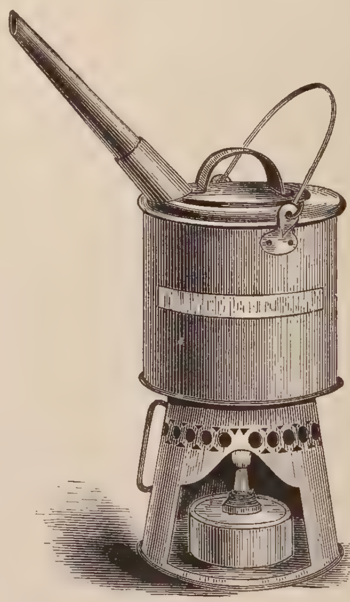


Fig. 4.—A croup kettle.

Though the hot-water bottle of which we have spoken may be filled with ice water or finely cracked ice and used as an ice cap, there is considerable advantage in

using a regular ice cap for the purpose, and of all ice caps, the so-called "Monitor" pattern is the best. This is a flat rubber bag, on one surface of which is a large opening with a projecting rim through which the cracked ice is introduced, and closing which is a tightly fitting cover. The use of the ice cap will be spoken of in treating of convulsions and headache. One caution is always to be observed in its use, and that is to place between the skin and the rubber cap an amount of cloth sufficient to prevent the blistering or even the freezing of the skin, an accident which has many times occurred, and which, though usually not dangerous, is none the less to be avoided. With these precautions the ice cap may be left on until the sensations of the patient require its removal, and even if the patient be unconscious no harm is likely to result from its use.

The Ice Cap.

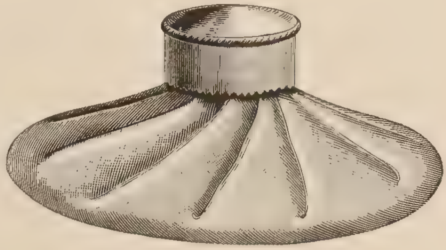


FIG. 5.—SCREW-CAPPED ICE BAG.

An invalid cushion is an excellent contrivance for use in cases required to maintain the same position for long periods of time. The best are made of rubber, in form like the old-fashioned doughnut, and are inflated with air. They are often spoken of as the "Peter Cooper" air cushions, from the fact that that philanthropist was in the habit of carrying one wherever he might go. They are placed beneath the buttocks of the patient, whether his position be that of sitting or lying upon the back, and, by their elasticity and their moulding themselves to the form, remove from the parts a pressure which might be injurious. Especially are they of service in conditions of low vitality and emaciation, for it is in these conditions that pressure upon the parts is so painful, and bedsores are so likely to result.

The Invalid Cushion.

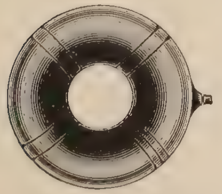


FIG. 6.—A RUBBER RING.

A glass rod is a cleanly and convenient instrument for dissolving and mixing medicines, and a glass dropper, with a pointed tip and a rubber bulb at its other extremity, is serviceable not only in measuring drops but also in dropping medicines into the eye, as has already been described in speaking of boric acid. One precaution is to be observed in the use of the medicine dropper, and that is the careful removal from the rubber bulb of all rubber dust before it is used for the first few times. A failure to observe this precaution might result not only in filling the medicine to be taken with rubber dust, but might act to fill the eye with that dust and thus

Rods, Spoons, Cups, Droppers, etc.

be responsible for severe and even serious inflammation. Of medicine spoons, cups, and graduates there are many, and they are often convenient.

The Glass Tube.

A glass tube is often used for taking acids and fluid preparations of iron, that injury to the teeth may not result. Such medicines are, however, not included in our list of household remedies, and the use of the glass tube by us will be restricted to the taking of medicines the more easily when lying upon the back, and the similar taking of fluid nourishment. In this way the necessity of having the patient disturbed by assuming the erect attitude is avoided. In serious or even milder illnesses this saving of effort and strength is of much importance, and while lying upon the back the patient may suck his medicine through the tube in ease and comfort.

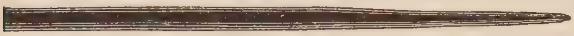


FIG. 7.—A GLASS ROD.

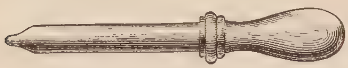


FIG. 8.—A GLASS DROPPER.

FIG. 9.—A GLASS FEEDING TUBE.

The Stomach Tube.

A stomach tube is recommended by some for use in the household, but its manipulation is one of considerable delicacy, and practice is required properly to perform it; even physicians sadly bungle the operation unless skilled in its practice. The object of the operation is to wash the stomach thoroughly and thus remove from it all noxious contents, but in the household the same result may be easily and safely accomplished by making the patient drink freely of *warm* water, and then causing him to vomit by placing the finger in his throat. A repetition of this process several times will result in as complete a washing of the stomach as could be done through the tube, and the process is one which requires no training, and can be done by anybody; besides, it is less disagreeable to the patient than is the tube in unskilled hands. The principle of the stomach tube or gastric siphon is, however, interesting, and though its use is not recommended, its working may be described. The

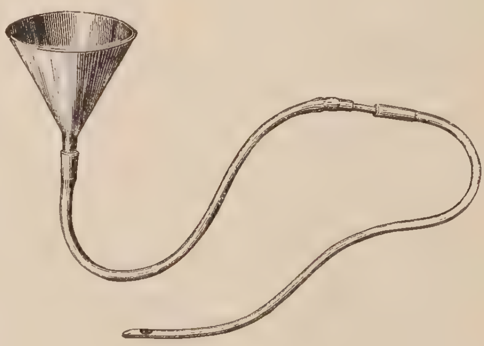


FIG. 10.—A STOMACH TUBE.

tube is made of rubber which, while soft and easily bent, is yet elastic and firm enough to maintain its calibre and not to be easily doubled upon itself. It is usually about two feet in length; the end for introduction is conical and closed, and near its point are two openings, one on either side. To its other end is fitted a similar tube of any convenient length and of any quality. The joint of the two tubes is made by inserting into the neighbouring ends of each tube a small glass tube, three or four inches long, in such a way that an interval of an inch or two of glass tube shall occur between the rubber tubes. This glass tube serves as a window through which the operator may look and observe the flow of fluid into or from the stomach, and observe its quality. The stomach tube proper is that portion first described, whose length is two feet; the common tube joining it may be called the external tube. Into the end of the external tube is inserted a funnel of hard rubber or glass.

The Use of the Stomach Tube.

In using the stomach tube the patient is seated in a chair, leaning over a basin. The operator moistens the conical end of the stomach tube in warm water and introduces it into the patient's throat; at the moment when it encounters the back of his throat the patient is told to swallow. By this action the tube is carried into the gullet, and the operator then, by gently pushing, forces the end of the tube down into the patient's stomach, the distance of the stomach from the teeth being sixteen inches in the adult. The introduction of this length of tube will therefore mean that it has entered the stomach. As a precaution the patient is now told to breathe deeply, for though it is unlikely to happen without a sufficient warning occurring in choking and coughing, it is theoretically possible to pass the tube, not into the gullet and stomach, but into the windpipe and lung. If the patient now breathes freely, and *not through the tube*, it is safe to assume that the passage of the tube to the stomach has been safely performed. The funnel is now raised, and warm water poured into it slowly and steadily until several cupfuls have passed down. (The capacity of the adult stomach is about three pints.) Then while the funnel still contains water it is quickly lowered to a level below that of the patient's stomach, when, a siphonage having been established, the fluid will flow through the tube from the stomach, carrying with it the stomach's contents. When the flow has ceased the funnel is again raised, and the process is repeated as many times as are necessary, until the water returns from the stomach as pure and clean as when it was introduced. The stomach is then held to be clean and the operation is concluded by the gentle withdrawal of the tube. This procedure is known as stomach washing, or lavage.

OTHER CURATIVE PROCEDURES, NOT DRUGS.

The part which drugs play in the treatment of disease is of course no small one, but yet there are other procedures the values of which are as great, and on diet, drink, rest, ventilation, and bathing many physicians place more dependence than they do on drugs. So strongly do many feel this that the era of drug-giving doctors, or "druggers," seems more than on the wane; and, while none doubt the necessity and value of certain drugs in certain conditions, the tendency of the profession is now to give far fewer drugs than did our medical ancestors of half a century ago. Of curative means other than drugs, none is more important than is diet.

Diet in Disease.

The diet in disease is a subject so extensive that a complete consideration of it can not be given here. A few brief statements in regard to it, however, will save our study from the accusation of incompleteness. In disease the activity of the digestion is generally lessened. How much this diminution amounts to will differ with the disease, but in general it may be said that the sick can digest less than can the well. The illness may be so mild that the diminution of food will properly be but slight, or it may be an acute fever, in which only the smallest amounts of the most easily digested foods are allowable. In acute disease, with the prostration of the patient, the foods generally withheld are the nitrogenous substances, such as meats. The sugars and the starches are only little more desirable, but the fats are our mainstay. Of fat foods Nature has provided us with one which is the ideal diet of the acutely ill, and that is milk. Milk is readily digested and highly nutritious; moreover, it is easily taken and generally well liked. In acute febrile disease of adults a tumbler of milk is to be given (if vomiting is not present) at intervals of two hours, and, generally speaking, it is the only food required in the more severe fevers. Broths and soups, indeed, may be given from time to time for variety's sake, but are in no sense substitutes for milk, since they in no degree possess its value as a food. Of late there has been a tendency to feed the feverish patient upon the simpler solids—such as meats, eggs, and the more easily digested vegetables—providing that his appetite demands them; and though to err on the side of prudence is wiser, yet there really seems to be no reason why a slight amount of fever should require the starvation of a hungry man. With the fall of temperature, however, the usual diet is gradually to be resumed with the gradual recovery of digestive power.

Milk Diet.

Chronic disease requires no such limited diet, for though, in general, what is true of digestion in acute disease is also more or less true of digestion in chronic disease, yet the preservation of nutrition in chronic disease becomes, from the very time involved, of a greater importance. In chronic

diseases, therefore, the highly nutritious foods are the most valuable; but at the same time the diet must be varied to some extent and not rigidly exclusive, else both appetite and strength will suffer.

Particular diseases require particular diets, but space does not permit of their consideration here, and for information upon the diets of such diseases as rickets, scurvy, consumption, dyspepsia, gout, rheumatism, and diabetes, the reader is referred to the chapters which treat of these diseases.

Drink in Disease.

The thirst experienced by the feverish patient is most annoying, and the torture he suffered at the hands of the old-fashioned doctor must have been intense; for then, as we know, the idea prevailed that to give water to one suffering from fever was to invite disaster. This belief is by no means entirely relinquished even at the present day, for, though physicians have long since learned the folly of this practice, it is no uncommon thing to find the feverish patient suffering unspeakably from thirst while water is withheld by the well-meaning but ill-informed attendant. So far from injuring the fever patient, water will only do him good, and now our effort, indeed, is to encourage his drinking freely of cool water as much as it was formerly to deny it. A moment's thought will show why the liberal drinking of water by such a patient will be beneficial. Primarily, it will relieve the suffering from thirst; it will increase the activity of the bowels, which fever ties up; it will tend to promote perspiration, which in turn, by evaporation, reduces the fever; it will increase the quantity of urine and make it less concentrated and irritating; it will of itself, if cold, reduce temperature somewhat; and, most important of all, by increasing all secretions of the body, it will carry off in them the waste products which fever causes, and which would otherwise remain to poison and to injure the body. Water, therefore, must be allowed to the fever patient freely, the sole forbidding condition being actual or threatened vomiting. Even if vomiting is present, small quantities of cracked ice, or water intensely cold, may be given at intervals, until the stomach has become quieted.

Water.

Water is the drink usually to be employed in fever, and though its use, unchanged and unmodified, in general will be sufficient, there are, in some cases, advantages in flavouring it. Thus, if thirst be insatiable and excessive, and if the free indulgence of water, in quantities sufficient to satisfy it, causes distress or nausea, it is well to acidulate it by adding to it a little lemon or orange juice, or even a little vinegar. A lemonade, in the same way, is beneficial, but care should be taken to add but little sugar. A cup of tea or a cup of coffee is often beneficial to the feverish patient, and possesses some advantage in the stimulating and strengthening actions these drugs exert

Other Drinks.

on nerve power. So far, therefore, from denying the patient accustomed to his occasional cup of tea or coffee the indulgence in them simply because he has fever, their moderate use is only to be recommended, and they may be given hot or cold. Alcoholic beverages will not be considered by us here. They are employed in fever, as in other diseases, but only for their value as stimulants where circulation is impaired.

It is not likely that the amateur practitioner will ever make use of the procedure to be spoken of, but it is interesting to know that water, introduced by the rectum and retained, will satisfy thirst practically as well as though swallowed. It is for this purpose, then, in cases where vomiting is continued and incessant and thirst is extreme, that injections of water into the rectum are at times employed with success.

Posture in Disease.

The position or posture of a sick person has much to do with the favourable or unfavourable progress of his disease, and therefore is an important element in treatment. To illustrate this importance we may cite the good results seen in cases of typhoid fever where the patient has been placed in bed in the earliest days, or even hours, of the disease, and the poor results in cases in which he continues around and about for some time after the invasion of the attack. In general, it may be said that in all diseases attended with weakening of circulation and impaired vitality the recumbent posture is to be insisted on, since circulatory and bodily power are subject to smaller demands, and hence are the better preserved when lying down.

Confinement to Bed.

In many cases the weariness and lassitude of a patient will be sufficient to determine his going to bed; and while this is a good guide, it is by no means always a safe one. The reasons for this are many: the fact that in many fevers the onset is so gradual that the patient, though seriously ill, does not realize this gravity; the fact that many people seem to have a constitutional objection to "giving up" and going to bed; the fact that some natures suffer little from prostration, even at the height of serious illness (as cases of pneumonia are often found in persons who have for days been about and at work); the fact that business interests may keep a man on his feet when he ought to be in bed; and the fact that in the first few days of fever the patient seems rather in a condition of excitement and stimulation than in one of prostration. For such reasons, then, the sensations of the patient should be consulted, and often serve as excellent guides to the treatment by posture, but they are certainly not blindly to be trusted.

Room, Ventilation, Heating.

The choice of rooms for the sick, the ventilation, the lighting, the heating—all these are important elements in treatment, but their consideration more properly belongs to other articles, and mention alone is necessary here. (See *Nursing the Sick* and *Hygiene*.)

Poultices, like almost everything else, are capable of causing harm or good, according to their applications; and though their employment in surgical affections is generally harmful, and for reasons set forth in the chapters on surgery, yet the physician often finds them useful, but in most inflammations in which pus formation is a probability, both surgeons and physicians agree that their application is unscientific and harmful. Poultices act by virtue of their warmth and moisture, and the soothing and relaxation they produce is of much benefit in the relief of pains. The pain of pleurisy and of pneumonia are among these, and it is probable that poultices not only relieve but aid to cure, since they are mild counter-irritants.

Poultices.

In peritonitis, as in pleurisy, the action of poultices is beneficial, and their application to the throat in a severe cold associated with hoarseness is excellent. In marked abdominal pain not due to inflammation—for example, the various forms of colic—poultices will often give much relief. As a generally safe rule, the laity may be advised *never to poultice an area of superficial inflammation, but rather to refer the case to the surgeon; yet, on the other hand, they may wisely apply a poultice for the relief of pain and inflammation of the deep-lying structures of the body.*

Uses of Poultices.

The size of the poultice will depend upon the area of the pain, and generosity in its construction is advised, since it is one of those good things of which one can scarcely have too much.

The materials from which poultices are made are many, for, as has been said, the poultice is active only by virtue of its warmth and moisture, and hence any application which possesses these characteristics alone is entitled to the name of poultice. Practically, however, the materials which we employ are flaxseed (linseed), bread, Indian meal, starch, and slippery elm. Of these, the most useful and most commonly used is flaxseed. How to make poultices will be told in the article on *Nursing the Sick*, and it remains but to say that care must be exercised not to apply them too hot, lest blistering result, an accident especially liable to happen if for any reason the patient's faculties are dulled. To avoid this danger, apply the poultice first to your own cheek, and if it can be tolerated there for a short space of time, it is not likely to injure the patient. The warmth of poultices may be retained for a considerable time by covering them with oiled silk, or even with several layers of thick cloth; but even so they will grow cold, and it is generally necessary to replace them after a period of two hours. Another precaution, too, as to poulticing will suggest the protection against cold of an area recently poulticed.

Varieties of Poultices.

Care in applying the Poultice.

The "dry poultice" is a name given to a thick layer of cotton wad-

ding applied to the body and covered by oiled silk or other heat-retaining material. The secretions of the patient beneath this application result in the necessary moisture, and the application itself furnishes the warmth. The dry poultice is milder in action than the ordinary poultice, but has the advantages of being less annoying to the patient and less troublesome to the attendant, for it requires no removal and reapplication. In the milder internal inflammations it is effective. It is also an excellent application to the acutely inflamed joints of rheumatism and gout.

The "Dry Poultice."

Of plasters there is a large variety in the "patent-medicine" market, and though most of them are possessed of the negative value of doing no harm, some few capsicum and porous plasters do seem really serviceable in diminishing the pain and inflammation of the muscles and deeper organs, since their action is mildly and continuously counter-irritant. These plasters are, however, essentially mild and generally applicable to the less acute affections. More energetic and more useful, too, is the old fashioned mustard plaster, or mustard paste.

Plasters.

The method of making a mustard plaster will be found in the article on *Nursing the Sick;* it concerns us now to consider its applicability. The action of the mustard plaster is as a counter-irritant application in the same conditions in which poultices are employed and in similar ones—indeed, mustard is sometimes added to the flaxseed poultice to make it more active. Though the applications of mustard plasters are similar to those of ordinary poultices, yet they are invariably more active, and to a greater or less degree depending upon the proportion of mustard employed. In general, it may be said that the strength will, or should, range from one part of mustard in four of flour up to one in twenty, the former being applicable where prompt action is necessary, as to relieve vomiting (in which case it is applied to the "pit of the stomach"), and the latter where a prolonged effect is desired, as in bronchitis. The age of the patient, too, and the delicacy of his skin will determine the strength of the application, those of weaker strength being applicable to children. The weaker mustard plasters may be left on for days at a time, and serve to maintain a constant and gentle irritation sufficient to keep an additional amount of blood in the skin covered, and therefore probably a smaller amount in the structures beneath. Care must always be observed, however, to avoid blistering, either by an application too strong or a continuance too long, and though the sensations of the patient are in general to be trusted, they are not always so. Subsequent protection of the area acted on against cold should be provided, as has been said in speaking of poultices.

The Mustard Plaster.

A stupe is simply a cloth wrung out in hot water and applied to the

skin as a convenient method of obtaining the well-known soothing effect of heat upon pain. Though the stupe is to be covered thickly with flannel to promote the retention of the heat, as far as possible, yet even so stupes will rapidly cool, and must therefore frequently be replaced. For these reasons, then, stupes are more applicable to pains of limited duration, and, as a rule, to those which are not dependent upon inflammation. Thus they are especially applicable for the pains of intestinal colic. For such a purpose the activity of the stupe will be promoted by sprinkling upon it a few drops of turpentine just previous to its application. The skin, if reddened, should be protected after the withdrawal of the stupe.

Stupes.

Bathing is not only of preventive value, but is also a curative procedure which has really been much neglected, and is even now scarcely receiving the attention it deserves. Not many years ago, indeed, the application of cool or even warm water to the fever patient was looked upon as quite as criminal as the giving to him of water to drink, and with about as much reason and success. Space does not permit us a full or even a sufficient study of the applications of water in disease, but a few words may well be given to the various methods employed. In this place, however, we shall deal only with the simpler applications of water in diseased conditions, reserving the consideration of the more elaborate employments of water, generally called "baths," for later consideration.

Baths, and the Use of Water in Disease.

The hot tub bath is stimulating and exciting, unless it is too long continued, in which case it becomes exceedingly weakening. Medical science has settled upon the number of thermometric degrees which shall constitute the hot bath, as well as the number proper to the warm, tepid, and cold baths. Such minuteness is not necessary for our purposes, however, and no error is likely to occur from a difference of opinion upon the meaning of the words "hot" and "cold."

The Hot "Tub."

To arouse and stimulate weakened vitality we may use the hot bath, and it is employed in cases of exposure (not, however, in frostbite or general chilling approaching the frozen condition [see *Frostbite*]), after drenching resulting from cold rain or from falling into cold water, in shock, and in impending death—particularly in the case of children, for in them the lifting into and from the tub will be easy, while in adults in itself it might precipitate a fatal termination. In such cases, then, the brief immersion in hot water will often suffice to stimulate the depressed and flagging vitality. The patient should remain in the bath only sufficiently long to experience stimulation, for a longer continuance is weakening. Great care, too, must be observed that exposure to cold does not occur after removal from the bath, else dangerous results may follow.

The Warm Bath.

The warm bath is soothing, quieting, and relaxing; but its long continuance is little less exhausting than is that of the hot bath, and after it the danger of taking cold is even greater. For this reason, then, it is far wiser to place the patient in bed subsequent to these baths. The conditions in which the warm bath is most valuable are those of nervousness, restlessness, and sleeplessness, and it is preferably to be taken just before retiring, and followed by a good rubbing. In hysterical and nervous subjects the warm bath is a curative procedure of much value.

The Cold Bath.

The cold bath is tonic, invigorating, and potent against fever. For its tonic and invigorating action it is usually administered by the sponge or the "dip," for from its very temperature a prolonged immersion is depressing in the extreme. This tonic employment of cold water is useful in conditions of overwork and loss of nervous force in those otherwise strong, and, as has already been said, its use should not be continued unless a healthy "reaction" follows. To lower the temperature of fever the cold bath may be given by sponging the patient with cold water at frequent intervals, drying him, and between the spongings covering him but lightly. It may be given in the form of the "cold pack," which consists in applying to the patient's body cloths wrung out in cold water and changed as frequently as heated, the procedure being continued until the temperature falls. Finally, the cold bath may favourably affect fever if the patient be immersed in a tub of water of 65° or 70° Fahr. as often as his temperature reaches or passes 102° Fahr. While in the bath the patient is vigorously rubbed to prevent depression, and for the same reason whiskey is usually given before the bath is begun. Moreover, when in the bath, cold water is frequently poured over the patient's head. It is this form of cold bathing which is now so often used in the treatment of typhoid fever, and it is generally referred to as the "Brand treatment." The common idea that bathing should not be done soon after a hearty meal is a good one, and is equally applicable whether the bath be hot, warm, or cold.

The Cold Pack and Tub.

The Foot Bath.

The foot bath is invariably given hot, and its effects are to stimulate the circulation, to reduce congestions within the body, and to induce sweating. The addition to it of a handful of mustard increases its effectiveness. In using it the temperature of the water is usually as high as can be borne, and the immersion of the feet continued as long as may be until the desired effect is accomplished. The cases in which the foot bath is generally employed are those where a congestion has taken place in some part of the body. In such cases the bath acts to stimulate the circulation, to relax the vessels of the skin, to induce sweating, and thus to equalize the circulation and withdraw the

blood from the congested parts. Its use in the first or congestive stage of colds, and in the pain so often present in the first days of a menstrual period, is thus explained.

The Hip Bath. The hip bath (or "Sitz" bath, as it is sometimes called) is of similar action, the heat, however, being applied by the patient sitting in the hot water. It is generally more inconvenient and rather less effective than is the foot bath.

The Sponge Bath. Sponge baths are given hot or cold, and as hot and cold baths have already been considered, but few words will be devoted to their application by sponge. The cold sponge bath is refreshing and stimulating in conditions of overwork and exhaustion, but, as in health, should never be given to those in whom vigorous "reaction" does not follow its employment. The cold sponge is also effective in reducing the temperature in fever, and in using it it is customary to sponge off one portion of the body at a time, to dry it and to cover it, that unnecessary exposure shall not take place. The warm or hot sponge is employed to soothe the patient, and especially in cases of nervousness and sleeplessness, where the brain contains too much blood. It is thought to determine a flow of blood to the skin, leaving the brain in an unstimulated and quiet state. Care must be taken to avoid subsequent exposure to cold, for so much blood being in the surface, there is then great danger of chilling, and serious results may follow. For this reason it is better to have the patient rapidly dried and at once put to bed.

The Alcohol Bath. Alcohol baths are usually alcohol rubs, and especially after exercise and muscular fatigue. The rubbing is probably a more valuable factor in such cases than is the alcohol, for by it the circulation is accelerated, and thus are removed the waste products in the muscles which result from exertion and on which the sense of weariness and lameness depends. The alcohol is a lesser factor, but yet is useful in cooling and in soothing the skin and safely stopping the sweating which has followed this exercise. In fever nothing is so grateful to the patient as sponging him at frequent intervals with a mixture of equal parts of alcohol and warm water. One part of the body should be sponged at a time, dried, and replaced in bed. This is calming and soothing; it diminishes the lameness and soreness so often present, and tends to reduce the fever. It may be used as often as the patient desires it.

The Mustard Bath. Mustard baths are hot-water baths to which mustard is added. Its irritating action upon the skin increases the effect of the heat. The addition of mustard to the foot bath has already been mentioned. As a general bath in the convulsions of children the mustard bath is invaluable, for by its action the quantity of

blood in the skin is much increased and the head is relieved of the morbid congestion on which the convulsions depend. The strength employed is usually of one handful of mustard to a child's tub of hot water, and the infant is kept in the bath until his skin has become well reddened, or until the tingling of the skin upon the nurse's arm shall warn her of a presumably similar tingling of the child's body.

The Sweat.

If a person is exposed to cold and wet, and especially, though it is singular, if his feet have been wet, there often results a congestion of some internal organ. Almost any organ may be thus affected, though the commonest are the nose, the throat, the lungs, and in women the pelvic organs. To such a condition we often give the name of a "cold," and say that the patient has "taken a cold." This naming is hardly scientific, but it certainly is descriptive, and conveys a clear meaning of cause and effect. Under such circumstances, if we can immediately produce a flow of blood away from the congested area, we may succeed in "breaking up the cold," and for this purpose nothing is more effective than a "sweat." By this the blood is made to go to the surface of the body, and in the relaxed vessels of the skin so much room is made for the blood that it drains away from the deeper organs, and among them the congested one.

To produce the sweat we place the patient in bed, cover him thickly with blankets, make him partake freely of hot drinks, and if some of them are alcoholic so much the better, though of course intoxication is carefully to be avoided. The sweating produced by these means is usually considerable, though it will be appreciably increased by a previously given hot tub bath. Dover's powder, eight tablets, administered to an adult only, will produce a perspiration still more marked. In fact, this medicine is usually employed by the physician for this purpose, and the sweating it causes is generally profuse. The degree of sweating necessary will vary with the severity of the case. After the "sweat" has continued sufficiently long for our purpose it is stopped by drying the patient, rubbing vigorously one part of the body at a time with rough towels, removing the superabundance of his bedclothing, and, if possible, placing him in a fresh bed which has previously been thoroughly warmed and dried. Such is the "sweat," and properly applied and in suitable cases it is a curative means of great value; it must not be used without caution, however, and for weak subjects it may not be proper to use it at all, since it is for them too exhausting. Even the strong and robust may be weakened if the "sweat" is continued too long, and the occurrence of weakness and faintness must in all cases be a sufficient reason for stopping it. Above all things, it must be seen to that at no time during or immediately following the "sweat" is exposure to cold permitted, for the danger from exposure when one is overheated can not be exaggerated.

Leeching is a treatment formerly most popular but now little practised. It is not likely that the lay practitioner will often wish to use the leech, and indeed he is not advised to, for a case requiring bloodletting is usually one which should be confided to the physician. A few words on the subject may not come amiss. The object of leeching is to diminish local inflammation by withdrawing blood from the inflamed area or its neighbourhood. Inflammations within the ear and severe inflammations of joints are often treated by this method. In the former case the leeches are applied just behind the ear, in the latter over the inflamed joint. Swedish leeches are supposed to be the best.

Leeching.

The ordinary medicinal leech is a small, wormlike animal, one extremity of which is provided with a sucking apparatus, by which it fastens itself to its victim and through which it draws into itself that victim's blood. The amount of blood which the leech will abstract depends upon his size and species, the range being from one to four teaspoonfuls. To apply the leech, the skin over the site of application is well cleansed, and, that the animal may be given a hint of what he is expected to do, a drop of blood or of milk is placed upon the chosen spot. The leech is then placed with his "business end" in contact with this drop, when he will at once begin his work, and after having consumed the decoy drop, which seems to have the effect upon him of an appetizer, he will fasten to the skin and withdraw blood to his capacity. When full the leech will fall off of his own accord; but if it be desired to rid the patient of him before that time a few drops of salt water placed upon his sucking end will cause him to let go. It is not at all uncommon for the bleeding from the leech bite to continue for some time after the withdrawal of the animal. If this occurs, the application of firm pressure upon the part with a thoroughly clean piece of cloth, or, this failing, the rubbing of the wound with a bit of alum, will usually check it. The number of leeches applied at one time will vary with the severity of the case; two or three are usual.

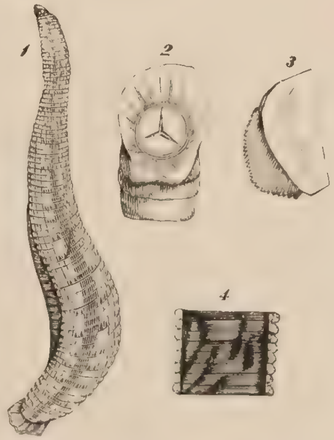


Fig. 11.—Hirudo medicinalis.
1, the leech; 2, anterior extremity magnified; 3, jaw detached magnified; 4, part of belly magnified.

A douche is, strictly speaking, the forcible projection of water against the body, and therefore the shower bath, the needle bath, and the throwing of water in bulk against the patient are as much douches as is the irrigation of the vagina with water. The popular use of the word douche, however, has this latter significance.

The Douche.

The use of the vaginal douche, in health and in disease, has a special rather than a general aspect, and for information upon this matter the reader is referred to the article which deals with the diseases of women and midwifery.

The Enema.

An enema is a rectal injection. Its objects are three: To move the bowels, to introduce food and drink within the body, and for the administration of medicines. The enema given to cause a movement of the bowels generally consists of soapsuds, made by agitating white Castile soap with warm water. Of this fluid about two pints will be the proper amount for an adult; for a child of eight or ten, a half pint. The method of introduction is as follows: Lubricate the small nozzle attached to a hand-bulb syringe with vaseline and place the other end of the syringe in the bowl of warm soapsuds. Compress the bulb of the syringe once or twice, and thus fill the apparatus with soapsuds; for if this is not done before the introduction of the nozzle within the bowel, the effect of the first squeeze on the bulb will be to fill the bowel with air, which accident will materially add to the patient's distress. Now gently insert the nozzle about one inch within the bowel, and then gently and steadily inject the fluid until the whole amount has been put in, or until the patient complains of pain. In doing this a towel will generally have to be pressed about the nozzle and against the opening of the bowel, that a tight junction of nozzle and bowel may result. Now withdraw the nozzle and hold the towel firmly over the bowel until it becomes evident that expulsion of the bowel contents must take place, then allow the intestine to rid itself, and with the water ejected will usually come the expected fæcal matter. If, however, the injection is not effectual, wait a short time and repeat it, and if the first injection is not discharged do not be alarmed, but give another, and with the second will usually come away the first. In obstinate cases the ordinary soapsuds enema may be insufficient, and the addition to each injection of one or two tablespoonfuls of castor oil, or one or two teaspoonfuls of glycerin, will add to its powers. If much intestinal wind disturbs the patient, one or two teaspoonfuls of spirits of turpentine in each injection may make it more effectual; but this addition is rarely necessary.

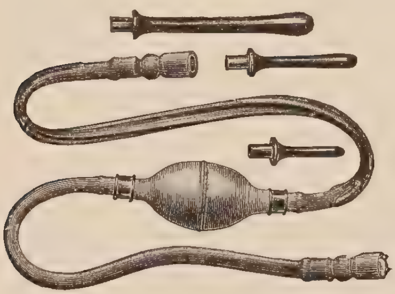


Fig. 12.—A hand-bulb syringe.

The "nutritive" enema is designed to introduce into the body the food which for some reason the stomach rejects. It becomes necessary, therefore, when vomiting is so persistent that starvation becomes a dan-

ger. Since the object in the use of nutritive enemas is that they shall be retained, they must, in contrast to the soapsuds enemas, be small. A half tumbler is the usual quantity. The enema is introduced usually not more often than once in four to six hours, for the bowel is an irritable tube, and a more frequent introduction would defeat the object of the procedure by causing the expulsion of the food. Such an enema may be made of peptonized milk (the directions for making this are given in the article on *Nursing the Sick*), and the addition to it of a tablespoonful of whiskey is generally advisable. Peptonized soups and prepared meat juices are also at times employed in nutritive enemas, as are the whites of eggs. While giving these enemas it is well to cleanse the bowel once a day by an ordinary soapsuds enema, that thereby absorption of the food may be less interfered with. Great care, too, must be had that the necessary manipulations are as gentle as possible, else irritation of the parts will result and a rejection of the food.

The introduction of medicines by the rectum will not be considered here save by the briefest of references, for that is a matter which concerns only the experienced practitioner. One drug alone may properly be so given by the non-professional, and that is alcohol. If a patient is in shock or collapse he usually can not swallow, and yet stimulation is what he needs above all things. Therefore it is eminently proper in such a case to inject into the bowel, and hold it in, a tablespoonful or two of whiskey or brandy mixed with a half tumblerful of rather hot water. A repetition of this injection may or may not be necessary, according to the effect of the first one upon the patient.

In two other conditions enemas of water are very beneficial—jaundice and hæmorrhage. In jaundice the injection into the bowel once a day of a quart of cold water will often produce rapid improvement; and it certainly ought to, for the treatment is disagreeable enough. In large hæmorrhages from any part of the body the injection into the bowel at once of moderately hot water to which common salt has been added in the proportion of a teaspoonful to a pint will often save life. The salt water thus injected when absorbed takes the place of the fluid the body has lost, and though not blood, it is better than nothing, and often sufficient. In such cases the hot salt water should be injected a pint at a time and held in, and after each injection the condition of the pulse carefully noted. If it becomes strong the treatment is sufficient; when it grows weak again the procedure is to be repeated.

In certain conditions—notably opium poisoning and drowning—the great danger lies in a cessation of respiration, and under such circumstances it may become necessary to employ artificial respiration. There are several methods of doing this, but by all odds the best is Sylvester's. It is done as follows: The patient is laid upon the back and a roll of

clothing is placed beneath him in the region of the lower ribs, to raise his chest slightly. The tongue is drawn from the mouth and held out, either by grasping it between two layers of cloth or by running a long hat pin through it. This "spearing" of the tongue may seem cruel, but the patient, be it remembered, is unconscious, and a tongue subsequently slightly sore is a small price to pay for a recovery from asphyxia. Especially is the pin of value when no one can be spared to hold the tongue.

Artificial Respiration: Sylvester's Method.

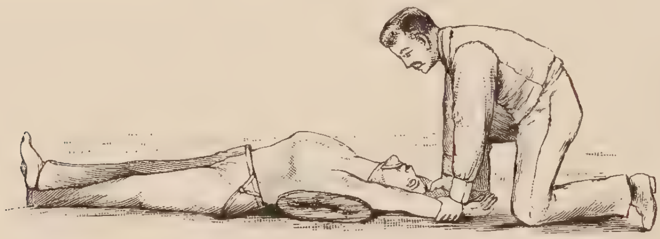


FIG. 13.—SYLVESTER'S METHOD—FIRST MOVEMENT (INSPIRATION).

The necessity for a protrusion of the tongue is almost self-evident, for the tongue of an unconscious patient who is lying upon his back will of necessity fall back into his throat and interfere with his breathing. Now, the operator should stand or kneel at the patient's head, and, grasping the patient's arms at about the elbow, should draw them up above the patient's head. This pulls the ribs of the patient up and out, the capacity of the

FIG. 14.—SYLVESTER'S METHOD—SECOND MOVEMENT (EXPIRATION).

chest is increased, and air rushes in as in a deeply indrawn breath. As soon as this has happened the operator lowers the arms of the patient to the sides of the chest and firmly but not roughly presses the elbows against the chest. This results in a forcing in of the patient's ribs, a diminution of his chest capacity, and air therefore rushes out through the throat, as happens in a forcible breathing out. Thus breathing is imitated, and, that the imitation shall be natural, the inspiration and expiration are each produced eighteen times in a minute, as is the case in

health. A persistence in this procedure for hours is often necessary before hope is to be abandoned, for often has it happened that such a persistence has been followed by the occurrence of spontaneous breathing and ultimate recovery. As the patient begins to breathe it is very important that the artificial expiration and inspiration shall be made to coincide with his breathing out and in, that the procedure may assist, and not oppose, the natural breathing. As the natural breathing grows stronger our efforts may be gradually relaxed and finally discontinued; but a relapse to the former condition is not uncommon, and for some time we must be prepared to repeat the treatment.

THE DISEASED CONDITIONS WHICH MAY WISELY AND PROPERLY BE TREATED AT HOME.

Introduction.

Our study so far has been of medicines and curative procedures, and in dealing with them it has been from the side of the remedy and not of the disease. It is now necessary to study the subject from the other side and, taking the diseased conditions as our starting points, to apply to them the proper remedial measures. Medicines have concerned us hitherto, but now we come to treatment. So much has already been said of the uses of drugs and their applications to disease that in our study of treatment it seems only necessary briefly and pointedly to lay down for each disease the appropriate treatment.

In an earlier part of this article a division into three sets was made of those conditions in which home treatment is justifiable. These are:

(1) Simple and trivial ailments.

(2) Emergencies pending the arrival of the physician.

(3) Conditions requiring professional treatment, and where no physician can be obtained.

A discussion of class three would mean a treatise on medicine, and this the author is not prepared to give or the reader to receive. With only a passing reference to this class, then, and an exhortation to "use your common sense" and "do the best you can," the author proceeds to deal with classes one and two.

SIMPLE CONDITIONS NOT REQUIRING A PROFESSIONAL ATTENDANT.

Biliousness.

"Biliousness" is a chronic ailment often running in families. It is very common in America, and yet it is as foolish to attribute every symptom not otherwise accounted for to biliousness as it is to fasten it on malaria, for indeed some people hold one of these responsible for every ill, from headache to corns. The symptoms of biliousness vary in number and severity with time and with individuals. They are a sallow, muddy skin, headache, foul breath, bad

taste in the mouth, dizziness, dulness, drowsiness, flatulence, and constipation, which at times is varied by an irritating, foul-smelling diarrhœa. The treatment should forbid overeating, should reduce the starches and sugars in the diet to a minimum, should reduce or exclude alcohol and tobacco, and should prescribe plenty of active and even violent exercise. There is nothing so good for the "torpid liver" as is exercise, especially horseback riding. The milder cases need no drugs; in the more severe ones a morning dose of Carlsbad salts is excellent. If at any time the symptoms become more severe, there is much benefit in a purgation by calomel. Children are rarely "bilious."

Chills.

Chills are characterized by pallor, shivering, chattering of the teeth, a sense of coldness, faintness and prostration, a weak pulse, and sometimes vomiting. Anything less marked is not a true chill, but a "chilly sensation." Chills often mark the beginning of serious illness, and are pronounced features of malarial fever. If the patient has previously had malaria, if he lives in a malarious locality, or if the chills occur at the same time on each day or on alternate days, the administration of quinine as already described should be begun. Whatever the cause of the chill, the relief of the immediate suffering is the same, and is summarized briefly in the word warmth. The patient is at once to be put to bed and warmly covered up, hot-water bags, or bottles filled with hot water and wrapped in flannel, are to be placed about him, care being had that they are not placed in immediate contact with his skin lest they burn him. Hot drinks are to be freely administered and a moderate amount of whiskey is beneficial. If fever follows the chill the usual treatment of fever is required, and if sweating occurs the precautions against taking cold should be observed, and have already been given.

Choking.

Choking occurs from the entrance of a foreign body, especially a piece of food, into the opening to the windpipe. Coughing will often remove it, and as aids may be mentioned a sudden and forcible compression of the chest by which the air is quickly ejected from the lungs and the foreign body blown from the windpipe, a vigorous slap on the back, and, in children, turning them "upside down" and gently shaking them. It is occasionally possible to remove the obstruction by introducing the fingers into the throat; but if this is done care must be observed lest the obstruction be forced down into the windpipe. In all severe cases the physician should be called at once.

Cholera Morbus.

Cholera morbus is marked by vomiting, purging, and cramps. In the severer cases it may become very dangerous, the patient's flesh melting away almost as we look at him. In such cases it resembles Asiatic cholera. The disease usually occurs in hot weather, and is apt to follow eating indigestible food or drinking con-

taminated water. In ordinary cases castor oil is first given to remove decomposing and irritating food from the intestine. This alone may be sufficient, and the diarrhœa stops. If the purging continues, tablets of "Sun Cholera Mixture" should be given, as already described. If much pain is present in the abdomen a generous one eighth mustard paste (one part of mustard to eight of flour) is to be applied and left on as long as possible. Food should be restricted to milk in small quantities, and if vomiting is present it may be modified as necessary for that condition. Water is allowed in small quantities, if intensely cold. In convalescence the food must be most simple and digestible. In all severe cases the treatment is upon a similar plan, but the physician's care is necessary.

Cholera Infantum.

Cholera infantum is a disturbance similar to cholera morbus which occurs in children under two years of age. The most valuable treatment is at once to remove the child to a different climate. If he has been taken sick in the city, he should be taken to the country; if at the seashore, he should be taken to the mountains; if at the mountains, let him go to the seashore. The object sought is change, and its effects are often miraculous, no matter how sick the child has previously been. Further than this the treatment is by a good wet-nurse or carefully prepared food, by calomel, and a mild mustard paste applied to the abdomen.

Colic.

Colic is popularly known as "cramps," and is the intestinal pain resulting from the effort of the bowel to expel undigested matter or fæcal accumulation. It is a symptom of cholera morbus, and is illustrated in the "green-apple" sensations of our childhood. The treatment is obviously the removal of the irritant, and castor oil or one of the "salts" is most effective. If the pain is very severe a mustard paste may be applied to the abdomen, and morphine may be necessary. Morphine, however, is only to be given to adults.

Constipation.

Constipation is a sluggishness of the bowels, and, though it is not an invariable rule, the normal intestinal condition requires one movement a day of a sufficient quantity and a hardness not too great. Constipation results from many causes, and a removal of the cause is always to be sought, for the mere taking of cathartics is wrong in every way, and aggravates the intestinal torpor, making the patient a mere dependent upon his pill.

Habit is one of the most common causes of constipation, and those indolent individuals who are too lazy to attend to this duty are sooner or later sure to reap the harvest of neglect in misery and ailing. The regular habit has already been discussed, and now we repeat only, have a regular hour for moving the bowels each day and keep the appointment religiously, for the bowels are good business men, and will be prompt and faithful if you are.

If constipation is due to biliousness, use the treatment already laid down for that condition. If it is due to old age—and it frequently accompanies advanced years—it is an evidence of the loss of strength of the intestine which must be expected, and as constipation is serious and even dangerous to the aged, it is wise for such patients to take each night, if necessary, one or even two of the compound aloin, belladonna, and podophyllin tablets.

Constipation often occurs in acute disease, and if so an occasional dose of a salt is beneficial unless the disease is one of the abdominal organs, in which case it is wiser to move the bowels by the soapsuds enema, for this disturbs and excites the bowels less than do cathartics taken by mouth. In the constipation of acute disease it is not worth while to upset the patient by causing his bowels to move every day; every second day is quite often enough.

The occasional occurrence of constipation in people otherwise healthy is to be treated by a glass of Hunyadi water, two compound cathartic pills, or even a few of our calomel tablets. In children the remedy by all means the best is castor oil or a small soapsuds enema.

The occasional constipation of infants is better not treated by cathartics, lest the habit be acquired; but by giving a little more water to drink, or a little oatmeal water occasionally, and, if necessary, by the introduction into the rectum of a small piece of Castile soap cut into the shape and of about the size of the sharpened (wooden) part of a lead-pencil. Indeed this soap suppository, as it is called, is one of the best means to combat the constipation of infants.

In treating constipation let the following hints be borne in mind: That milder measures must always be used first; that the danger of a dependence upon drugs is great; that exercise, free water-drinking (indeed, a glass of ice water taken before breakfast is an excellent laxative), an avoidance of tea, and a diet which contains green vegetables, fruits, oatmeal, cracked wheat, prunes, dates, and figs, are agents more valuable for this purpose than all the drugs our medicine chest contains, and far less likely to do harm.

Cough.

Cough is a symptom produced by so many diseases that a thorough consideration of its treatment is out of the question, but the commoner conditions causing it may be discussed briefly. In inflammations of the throat cough is generally present, and in such cases is usually hacking and accompanied by little expectoration. For these cases a throat specialist should be consulted, or, at any rate, the physician. A spray of Dobell's solution used three or four times a day will, however, often be beneficial, and never harmful.

If cough is associated with hoarseness, it means an inflammation in the neighbourhood of the vocal cords. It is well in such cases to surround

the neck with a thick muff of cotton, that the soothing value of warmth may be had, and care should be taken that no exposure to cold occurs. If the hoarseness is extreme, the inhalation of warm steam is of great benefit. Ipecac, $\frac{1}{10}$ grain every fifteen minutes, is very useful.

If the cough is accompanied by oppression over the chest and the other evidences of a heavy cold, bronchitis is to be inferred, and the treatment should include ipecac in small doses and frequent rubbing of the chest with turpentine and sweet oil, or the "stimulating liniment." Cotton, too, should be thickly applied to the chest, and exposure avoided. If the bronchitis is a very severe one, there is considerable efficacy in a calomel purge and a "sweat" if the case is seen very early.

The cough of pneumonia and the cough of consumption are scarcely to be treated by the laity, and in the suspected presence of these diseases the physician's advice should always be sought.

Croup.

Croup is the hoarse, brazen, crowing noise made in the throats of children when suffering from inflammation or spasm of the vocal cords.

The spasmodic croup occurs in attacks. In the intervals the breathing is normal. In these attacks the child will suddenly begin to breathe with difficulty, and to make at each inspiration the "croupy" noise in his throat. Nothing so well suffices to relieve as to make the child vomit. To produce vomiting in young children it is best to give a half-teaspoonful of the syrup of ipecac every fifteen minutes until vomiting occurs, or until four or five doses have been taken. Warm water may also be given, and the finger inserted in the child's throat to cause vomiting.

If the croup is of the inflammatory kind ("catarrhal croup"), the symptoms are not paroxysmal, but continuous. In these cases a weak mustard plaster should be placed upon the neck of the child and kept on as long as possible, the skin being protected subsequently by a thick covering of cotton. The inhalation of steam from the croup kettle will also be of benefit. The physician's advice should be sought in such cases, however, for catarrhal croup may become a serious condition, and, too, there is often much difficulty in telling whether the case is one of catarrhal croup or diphtheria.

Diarrhœa.

Diarrhœa means past or present intestinal irritation, and as, generally speaking, we can not be sure that the irritation is past, it is wiser to free the bowels by a good cathartic, such as castor oil or a "salt." Often this alone will stop the diarrhœa by removing the irritant, but if not, the administration of the "Sun" cholera tablets is to be recommended. If the diarrhœa has lasted for some time, and it is probable that the irritant has escaped from the bowel, the purge should be omitted and the tablets at once be given. Especially is this

practice recommended in case the patient is so weakened that further purging of itself would be objectionable. The diet in diarrhœa should in adults be restricted to milk, and if there is any doubt as to the freshness of the milk it should be boiled. In children diarrhœa sometimes calls for a diet containing no milk at all.

Earache.

Earache is very common in children, and may often be relieved either by wrapping in cotton or by the application of a well-covered hot-water bag. Another way of treating earache is by placing the ear over a pitcher of hot water, and covering both ear and pitcher with a cloth to confine the steam. This treatment is said to be most excellent. If, in spite of these remedies, the pain persists, no time should be lost in calling a physician. Never put any fluid in the ears without first consulting a doctor.

Epilepsy.

Epilepsy is commonly known as "fits," and is a disease characterized by convulsive attacks of uncertain causation, which from time to time affect the unfortunate "epileptic." The attack itself is almost never dangerous, no matter how alarming, and though the physician can do much to benefit the disease, the uninitiated can do nothing save to prevent self-injury during an attack. Interference, then, beyond the prevention of falling downstairs and similarly dangerous accidents, is not only useless but harmful. In those suffering from epilepsy an unstimulating diet, largely composed of fats and green vegetables, will tend to reduce the frequency of the paroxysms, and in these patients the bowels should be kept freely open.

Inflammation of the Eyes.

Inflammation of the eyes may be very innocent or very dangerous, and therefore, if any doubt upon the subject occurs, the physician is at once to be summoned. In that simple condition, however, in which the eyes become burning, painful, and watering, and in which their appearance is "bloodshot," the solution of boric acid (see *Boric Acid*) dropped into the inflamed eye two or three times a day will be of great benefit. In all cases of severity an avoidance of light is to be recommended.

Fainting.

Fainting is really so harmless a thing that no treatment is needed for it, and it is rather for the sake of doing something, and for the satisfaction of sympathetic friends, that treatment is pursued. As a matter of fact, the necessary treatment is confined to placing the patient in such a position that the head shall be slightly lower than the heels, so that with the return of blood to the head, thus produced, the fainting will cease. There is no objection, however, to holding smelling salts beneath the patient's nose, to sprinkling water upon him, and to chafing his hands; but practically these things are generally unnecessary, since the faint will terminate of its own accord within a very few minutes. Upon recovery from such an attack, rest, warmth,

loose clothing, and a mild alcoholic stimulant are to be recommended. Exceptionally, fainting attacks are of longer duration, and then the physician becomes necessary, for not seldom such an attack is the evidence of a condition of some danger. The effect of lowering the head in curing fainting may also be used to prevent an attack, for when the premonitory symptoms appear the patient will often succeed in warding off their further development by promptly seating himself and placing his head between his knees.

Fever.

While it is true that fever is an elevation of temperature above the normal, it is equally true that in this connection the normal point can not be fixed arbitrarily at 98·4° Fahr., for many things operate to cause trivial elevations above that point, and these can scarcely be dignified by the name of fever. Generally speaking, then, 100° Fahr. will be a safe dividing line between fever and no fever. An elevation of temperature above 100° Fahr. is a frequent accompaniment of chronic diseases, but it is usually slight, and in itself seldom requires treatment. The temperature of acute diseases is more pronounced, and it is the treatment of acute fevers which we shall now discuss. Absolute rest in bed and a fluid diet have already been laid down as generally essential to the treatment of fever. The care of the bowels has also been mentioned. It remains, therefore, to speak of treatment of the temperature itself. This temperature may be reduced and the patient made far more comfortable if the sponge bath of alcohol and warm water is frequently given. In adults the administration of phenacetine in five-grain doses every four hours will produce similar results, and in the larger number of fever cases this combination of alcohol-bathing and phenacetine-giving constitutes a treatment of great effectiveness. In all fevers, if long continued or severe, circulatory weakening becomes a danger, and must be combated by the administration of alcoholic stimulants in quantity sufficient to slow and strengthen the pulse. The mouth of the fever patient must be kept scrupulously clean by frequent washing with water or the glycerin and boric acid solution already mentioned. The importance of this care can not be overestimated, and applies equally to the patient's comfort and his safety—his safety, because the connection between a foul mouth in fever and a complicating pneumonia is a direct one.

The popular idea that a patient with fever is to be bundled up in thick bedclothing is as erroneous as is the idea that cold water to drink is not to be allowed him, and a greater absurdity than to bundle a patient up in clothing and expect his temperature to fall can not be imagined. So far from this, his bedclothing should be light in the extreme, for the patient with a high fever can not take cold in the ordinary sick-room unless such folly is practised as allowing a direct draught of air to fall upon him.

Moreover, light coverings tend to allow the fever to fall and thus contribute to the patient's recovery and his comfort. With the fall in temperature only does the necessity for more covering arise. Whether it will be allowable for the patient to rise from bed to attend to the evacuation of his bowels and bladder will depend upon the severity of his disease; but in case of doubt the recumbent position should be absolutely and continuously maintained, and the use of the bedpan therefore becomes necessary. Such, then, is the treatment of the condition, fever, whatever its cause. Further than this the treatment of the feverish patient is the treatment of the cause producing his fever, or, if that is impossible, the relief of his various symptoms. In convalescence from acute fevers the return to the usual habits must be gradual, though this too will vary with the severity of the attack and the exhaustion it has produced. At first sitting up in bed is allowed, and then a few minutes or hours in a comfortable chair till, with returning strength, the usual habits are resumed.

Flatulence.

Flatulence means the occurrence of gas in the stomach or the intestines, and is the result of decomposition of the food. It is especially common in the bilious and those who eat the sugars and starches in large quantity. For the relief of the condition the biliousness and the diet must be corrected, and in many cases the administration of the rhubarb-and-soda mixture in doses of one tablespoonful before eating is advisable. For immediate relief from the pain which flatulence may produce ("wind colic") almost anything hot, stimulating, or aromatic will be beneficial—hot water, tea, whiskey, or tincture of ginger. For children, peppermint water will answer the same purpose.

Headache.

Headache may be due to any of "a thousand and one things," and space permits of consideration of only the commonest of the causes. Constipation is one of these, and a removal of the contents of the bowel is followed by relief from the pain. Eye strain is another very common cause, and may be inferred if the headache follows much use of the eyes, or if there be smarting and watering of the eyes. The care of the specialist is, of course, necessary in such cases. The nervous headache is one of the most difficult to treat, for it involves the removal of the hysterical "habit" of the patient. Briefly, for such cases we employ exercise, diet, rest and sleep in plenty, the removal of irritations, and all measures which may be necessary for a perfectly healthy life. At the time of the pain nothing is so good as sodium bromide given in doses of five grains every half hour until the headache has ceased, or until four or five doses have been taken. "Sick headache" is another common form, and is most defiant of permanent cure, though the relief of the attack is not difficult. It is accompanied by nausea and vomiting, and is apt to be located in one side of the head only. For relief, phena-

cetine may be given in doses of five grains every half hour until three doses have been taken; but a free purgation by calomel followed by a "salt," though slow in action, is a good treatment. Headache often occurs as a symptom of fever, and requires the treatment appropriate to fever. Malaria is a frequent cause of headache without other manifestations of the disease. The pain is apt to be located in the forehead, and hence is often called "brow ague." It is to be inferred from the probability of malarial infection. The appropriate treatment is by quinine—five grains three times a day for a few days, and then a gradual lessening of the dosage. Biliousness is often a cause of headache, and is to be recognised by the other symptoms of that condition. Headache is a constant symptom of meningitis, or, as it is popularly though incorrectly called, "inflammation of the brain." In this case it is exceedingly severe. In general it may be said that if a headache is sufficiently severe to prevent sleep entirely, it is indicative of cerebral mischief. For such cases as these the physician is, of course, to be summoned. Though each of the foregoing headaches has its appropriate treatment, they are all more or less slow in operation, and for the immediate relief of the pain there is nothing more effective than the giving of phenacetine, as has already been described. The ice bag applied to the head is valuable in many cases, as is generally a freely and rapidly acting purge. In the severer forms of headache morphine may be necessary. For the headache of children the ice bag is the safest treatment.

Hiccough.

Hiccough is due to a spasmodic contraction of the diaphragm, the large flat muscle which separates the chest cavity from that of the abdomen, and by whose movements air is drawn in or forced out from the lungs. It may be caused by many things, among which are fever, diseases of the brain, and hysteria; but of all causes the commonest is indigestion. An attack of hiccough is usually a slight thing, and easily remedied by holding the breath until the spasm of the diaphragm ceases, by taking a little bicarbonate of soda, or even by taking a glass of hot water. Sometimes, however, hiccough is a persistent and exhausting condition—so exhausting, indeed, as occasionally to be the cause of death. In persistent cases, therefore, professional advice is to be sought.

Hysteria.

It is impossible to give in the short space allowed to us a complete or even a fair description of hysteria and hysterical manifestations—indeed, volumes might be written on the subject, and the disease still remain incompletely described. We all know what hysteria is; it is nervousness of an exaggerated kind—not merely the alternation of crying and laughing which occurs in attacks, but any strange and sensational and exaggerated manifestation which has no physical and demonstrable cause. The hysterical nature of

"queer" performances may be inferred if the subject is a young woman, if she is in poor health, if she is known to be "nervous," and if she has had previous attacks. In all the hysterical manifestations, moreover, the patient evinces a marked desire for attention and observation, and in the absence of a witness the hysteria usually will disappear. The treatment is to cure any present disease and by regulation of life, and by all hygienic means to establish "a healthy mind in a healthy body." For the attack, or violent manifestation, nothing is so bad as sympathy and coddling, and if the symptoms are sufficiently severe a vigorous sousing with cold water will generally bring the hysteria to terms—in fact, the contents of a siphon of Vichy water well aimed and discharged in the face of a hysterical patient was formerly so popular a treatment in our hospitals that its very popularity necessitated its abolition from motives of economy.

Intoxication.

Intoxication generally requires no treatment, and the usually manifested desire of the victim to sleep is Nature's cure, on which we can not improve. If we can make the patient vomit—and it is usually not difficult—we shall hasten his recovery, and for this the repeated administration of warm water is the most simple method we can employ.

Loss of Appetite.

Loss of appetite is one of the symptoms of ill health, and its relief will generally depend upon the removal of the cause, whatever that may be. In acute illness the appetite need not concern us, for it will return with the patient's recovery. From time to time, however, we see patients in whom loss of appetite seems their only ailment. In such cases exercise will often restore the desire for food, and the administration of the rhubarb-and-soda mixture will accelerate that restoration.

Muscular Rheumatism.

Muscular rheumatism is a painful condition of the muscles which usually follows exposure to cold and dampness. The muscles oftenest affected are those of the neck, back, and chest. The pain usually is more marked upon moving the affected muscles. The trouble may be so slight as really not to necessitate treatment, and disappears of its own accord in the course of a few days. If treatment is required, however, phenacetine may be given in doses of five grains every four hours, and the muscles rubbed with the "stimulating liniment." In very severe cases rubbing may be too painful a procedure, and here nothing does so much good as a 1-to-6 or 1-to-8 mustard paste applied over the painful area. In children the treatment is by rubbing with the mixture of turpentine and sweet oil already described.

Nosebleed needs no definition. In cases of mildness it may be sufficient to have the patient sit in the erect position, to apply ice to the nape of the neck and bridge of the nose, or to press firmly and continu-

ously upon the upper lip. In cases more marked nothing is so good as the irrigation of the bleeding nostril with hot water. This is done by filling a fountain syringe with water as hot as can be borne, and then directing the end of the tubing a short distance up the nose and allowing the water to pass up the nostril and even back into the throat. This treatment is generally efficient, and should be persisted in. In very severe cases, however, nothing succeeds but plugging the nose tightly with cotton or clean cloth; but here, and indeed in all cases, the throat must be looked into, lest the bleeding continue from the posterior part of the nose and into the throat. In such cases the patient may swallow the blood and later vomit it, or may expectorate clotted blood by clearing the throat. These things will of course call our attention to the condition of affairs, but they do not invariably occur, and hence the necessity for inspecting the throat. If posterior bleeding does occur and is continued, the physician's skill will be required. (See *Surgical Injuries and Surgical Diseases.*)

Nosebleed.

So many people have an objection to growing fat, and so many antifat absurdities are practised, that it seems advisable to give a few words to the subject. With the exception of extreme cases it is as natural for some people to be stout as it is for others to be thin, or to have blue eyes or light hair, and the pursuit of fashionable slenderness by such people is unnatural and often productive of ill health. In cases of *extreme and unnatural obesity*, however, we have a real disease and one which should be combated. To accomplish this, exercise should be had in plenty, the food should exclude the fats, the sugars, and the starches, the bowels should be kept open freely by the use of "salts," and an occasional Turkish bath may be employed. The too frequent use of the Turkish bath is unwise and weakening. By sufficient employment of these means the desired result will generally be accomplished. Of the many "cures" for this condition now popular, let it be understood that they are principally humbug. Moreover, the popular impression that drinking little water, smoking, and drinking vinegar will produce diminution of flesh is false. Starvation will of course cause emaciation, but it will also cause disease. Few people realize that in their employment of artificial aids to getting thin they are using remedies which are either worthless or which, if effective, are likely to cause serious disease and hence are dangerous. To reduce the flesh, then, pursue the legitimate means we have given, and if you lose weight well and good, if you do not carry it too far and also lose health and strength; but if, in spite of these means, you remain fleshy, then be content, for Nature intended it to be so.

Obesity.

The condition of painful menstruation is one which usually has some local cause, and therefore such cases are usually appropriate for the spe-

cialist; but the suffering at the time of sickness is susceptible of considerable relief by simple and harmless means. As in the convulsions of children the problem is to bring the blood away from the congested brain, so in painful menstruation the problem is to reduce the congestion of the pelvic organs which is associated with this condition, and it is accomplished by similar means. The patient suffering from this painful menstruation should have a hot mustard foot bath and quickly get into bed, should be well covered up, and have a hot-water bag applied to the feet. Hot drinks should be taken, and though a vigorous "sweat" is generally to be avoided, yet the warmth is eminently beneficial.

Painful Menstruation.

Many people complain of "rheumatism" when they are suffering from vague pains in the joints, in the muscles, and in the bones. These pains may or may not be rheumatic, and as a matter of fact in a considerable proportion of the cases they are not. Many of these patients are aged, and treatment is of little avail, but yet something can be done and sometimes much benefit will result. For such patients are recommended an out-of-door life, yet with avoidance of exposure, an abstinence from alcohol, tea, coffee, and tobacco, a diet to consist largely of fats and green vegetables, and the administration daily of Carlsbad salts in sufficient doses to move the bowels once or twice. For the pains themselves rubbing with the "stimulating liniment" is to be recommended.

"Rheumatic" Pains.

Sleeplessness is an ill which requires much care in treatment, for if drugs are employed the danger of forming a drug habit is great. No such drugs should therefore be given by the laity, and hence it is not our purpose to recommend or speak of them. There are simple means, however, which are often sufficient to cause sleep, and these act by causing a removal of blood from the oversupplied brain to some other part of the body, for in sleep it is supposed that the brain contains less blood than in wakefulness. The means to be recommended for this purpose, then, are a warm bath immediately before retiring, a cup of hot water taken at bedtime, or a light and digestible supper, a hot-water bottle at the feet, warm bedclothing, a quiet room, and—though the possible habit is not to be lost sight of, and therefore the suggestion is made with reluctance—a glass of beer. In the sleeplessness of acute disease, where from the brevity of the time of employment no habit is likely to be formed, the use of sodium bromide is allowable.

Sleeplessness.

Sore feet is a name by which we mean to describe not distinctly inflamed feet, but that condition of soreness often associated with burning sensations and an abundant production of perspiration. Such a condition is exceedingly common, and occurs particularly in certain individuals and families, in hot weather and fol-

Sore Feet.

lowing much walking. For its relief the feet should be bathed once or more each day in equal parts of alcohol and water, the stockings should be white and changed each day, and the wearing of the yellow or tan-coloured shoe is undeniably advantageous, especially if two pairs are used in daily alternation. A powder consisting of one part of salicylic acid with fifty parts each of starch and zinc oxide may be kept applied to the feet, and is a most effective remedy.

Sore Mouth.

It often happens that persons in whom there is indigestion suffer from slight spots and sores in the mouth, to which the popular name "canker sores" is applied. These are an annoyance rather than a disease, and usually will promptly disappear if the diet is regulated and the rhubarb-and-soda mixture is taken for a few days. In children there occur from this cause, as well as from neglect to keep their mouths clean (the mouth of a child should be washed out with warm water or boric-acid solution after each feeding), small white spots and ulcers upon the tongue, gums, lips, and cheeks. For the removal of these "sprue" or "thrush" spots nothing is more valuable than a frequent washing of the parts with a mixture of glycerin and saturated solution of boric acid, equal parts (see *Boric Acid*). (See *Surgical Injuries and Surgical Diseases.*)

Sore Throat.

So many are the kinds of sore throat that in the presence of doubt as well as of severity the physician's advice must be sought, for it is to be remembered that the onset of so grave a disease as diphtheria is not infrequently mild. If previous experience, however, has produced familiarity, if contagion can be excluded, if exposure or indigestion has been present, if the appearance of the throat is indicative only of mild and simple inflammation, then may home treatment be employed. For the relief of the simpler forms of sore throat a gargle of hot water may be used every two or three hours, or the iced solution of chlorate of potash already described, for either hot or cold applications seem efficient. If fever is an accompaniment of the attack—and it often is—the usual treatment of that condition is required. Some patients, and especially children, are sufferers from frequently repeated attacks of sore throat, and to combat this tendency the stomach and the diet should receive attention, only the plainest of foods being allowed. In such cases the plumbing of the patient's house may be found faulty, and with its correction the attacks cease. Local throat conditions may account for the attacks, such as overgrown tonsils, and then the specialist is required. To lessen the tendency to repeated attacks, daily sponging of the throat and upper part of the chest with cold water is of considerable value, as it is in the prevention of bronchitis.

Styes are abscesses of the eyelids which, though small in size, are large in their power to torment. They are apt to be rapidly repeated

for some length of time unless checked by treatment. When the early symptoms of stye appear and are recognised by those familiar with them, frequent bathing of the lid in very hot water will sometimes suffice to "head off" a further development. More effective than this, however, is a preparation to be had at any pharmacy, which is called "the syrup of the hypophosphites with iron." A teaspoonful of this taken three times a day, after meals, and in water, will often stop an incipient stye, and, furthermore, prevent the appearance of its descendants.

Styes.

Toothache needs no definition, but it calls for treatment. We need not describe the application of the hot-water bag to the cheek; its use is familiar to all, and generally is remarkable for its failures. If the aching tooth contains a cavity nothing is more effective to relieve the pain than the placing in it of a small piece of absorbent cotton which has been soaked in creosote, oil of cloves, or a strong solution of carbolic acid. These drugs are powerful irritants as well as poisons, and therefore they must not be carelessly dropped upon the gums and lips, and the bottles containing them must not be allowed carelessly to stand around. The occurrence of toothache is a warning to visit the dentist, and so strong a hint should never be neglected.

Toothache.

To cause vomiting is a procedure necessary whenever anything abnormal in quality or quantity has been swallowed the retention of which would be prejudicial to health. It is also desirable in obstruction of the breathing from croup. Various means are employed for this purpose, and include the drinking of lukewarm water in large amount, irritating the palate and pharynx with the finger, the drinking of warm salt water, or of warm water containing mustard in the proportion of a tablespoonful to each tumbler. Syrup of ipecac is a most valuable emetic, and especially useful for a child. The use of the drug for this purpose has already been described (see *Syrup of Ipecac*).

To Cause Vomiting.

To stop vomiting becomes necessary in derangements of the stomach in which it is not harmful food which is being ejected, but in which water, milk, soups, and the blandest and most suitable of foods are being thrown off. To cause the vomiting to stop, milk should be given in very small amounts at intervals of a quarter to half an hour, should be intensely cold, and if not then retained may be modified by the addition to it of limewater, as already described. To assist in the retention of food a strong mustard paste (1 to 4 in adults) should be placed upon the "pit of the stomach," and retained there as long as possible. If the vomiting is frequently repeated and exhausting, there is much value in washing out the patient's stomach, and this is done by inducing him to drink liberally of warm water, which, being almost immediately rejected, brings with it the irritating matter, on the presence

To Stop Vomiting.

of which in the stomach the persistence of the vomiting depends. This procedure is to be repeated until the vomited water returns clear and pure, when a cessation of the trouble, at least temporary, will almost invariably ensue. In *severe* vomiting, however, one of our morphine tablets may be required, but should never be employed unless other means have failed. If necessary, it should be given dissolved in a teaspoonful of ice water, but only to an adult.

So much, then, for simple and trivial ailments, though in our discussion of them we have again and again spoken of the possible necessity for calling the physician, and have attempted to indicate those conditions which require his presence. Remember that in general mild cases only are to be treated at home, and that severity and doubt always call for medical advice.

EMERGENCIES DEMANDING A PROFESSIONAL ATTENDANT.

In this class there naturally belong more conditions of a surgical than of a medical nature, but, as has already been said, this article relates to medicine only, and for information in regard to surgical emergencies the reader is referred to the article on *Surgical Injuries and Surgical Diseases.*

Apoplexy.

Apoplexy may be inferred if a man beyond middle life suddenly becomes unconscious, with possibly slight convulsive movements of some part of the body which last but a short time, and if his appearance in the "stroke" is of marked redness of the face, snoring, noisy breathing, and slow and over-forcible pulse. In such a state it seems almost imperative that "something must be done"; but, unfortunately, nothing can be done by the laity, and little in fact by the doctor. Send for the doctor at once, however, and in the meantime raise the head of the patient upon pillows, loosen the clothing about his throat and chest, place him in as comfortable a position as possible, avoid shaking or moving him unnecessarily, avoid giving anything alcoholic, and—wait.

Bleeding from the Lungs.

Bleeding from the lungs is more alarming than dangerous, and though it *may* cause death, it does so rarely. This bleeding usually occurs as a symptom of consumption, but many consumptives never bleed from the lungs, and, on the other hand, the bleeding not infrequently occurs without consumption. Quiet is to be insisted on in such cases, both to reduce the activity of the heart which would result from excitement and which would increase the bleeding, as well as to diminish the cough. Still more surely to accomplish these ends, give (to an adult) two of our morphine tablets dissolved in water and await the arrival of the physician. *Remember that under no circumstances should alcoholic drinks be used.* As a matter of fact, the hæmorrhage will usually cease of its own accord, and the physician can

do little more than the things we have mentioned. Yet he should invariably be called, for the condition may turn out grave in spite of first appearances to the contrary.

Some difficulty may arise in distinguishing bleeding from the lungs from bleeding from the stomach, and in such a case the following points may be found of service: In bleeding from the lungs a cough is almost invariable; in bleeding from the stomach it is not, but vomiting is present. In bleeding from the lungs the blood is usually bright red and frothy; in the other case it is more apt to be dark, tarry, clotted, and to contain food.

Bleeding from the Stomach.

Bleeding from the stomach is to be combated by applying the ice cap over the pit of the stomach and keeping the patient as quiet as possible—if necessary, by the administration of morphine (for an adult two of the tablets dissolved in a very small quantity of ice water). This morphine has the additional advantage of tending to diminish the vomiting. It is recommended by many that ice should be sucked, and even that small pieces of it be swallowed, in cases of vomiting of blood. This, however, is treatment of doubtful value, for the water swallowed may increase the vomiting, and hence the bleeding it is our object to stop. As in other bleedings, the giving of alcoholic drinks is strictly to be avoided.

Bleeding from the Bowels.

In bleeding from the bowels the same treatment is pursued as in bleeding from the stomach, save only that the ice bag is applied over as much of the abdomen as possible. Whether this treatment is effective is doubtful, and the outcome is probably little influenced by our interference, and yet we use these means in the absence of others more trustworthy. In bleeding from the bowels no purgative medicines or enemas should be used for several days lest by the activity of the intestines thereby induced the hæmorrhage should again begin.

Unconsciousness.

The treatment of unconsciousness, save those states already described, is, from the standpoint of the laity, mainly one of non-interference. In such cases, therefore, loosen the patient's clothing that he may breathe easily, place him in as comfortable a position as possible, and avoid disturbing and exhausting him by unnecessary moving; if his face is pale, let the head be placed low; if the face is red and flushed, let it be elevated on pillows. Further than this, do nothing until the physician arrives, unless the unconsciousness is manifestly one of those we have more carefully described, such as fainting, drowning, apoplexy, sunstroke, epilepsy, shock, and opium poisoning. For these the treatments have been given.

Convulsions in adults are relatively uncommon, and if they occur the uninitiated can do nothing more than prevent self-injury by the patient.

In children convulsions are of frequent occurrence, and arise from a great variety of causes. First and foremost, the convulsion is to the young child what the chill is to the adult, and therefore when a disease would begin with a chill in an adult, its invasion in a child is marked by a convulsion. For this reason a convulsion in a child may mean the beginning of measles, of scarlet fever, of diphtheria, of pneumonia, and a host of other acute diseases. Beyond these, convulsions in children often result from the most trivial causes. Thus they not infrequently arise from the cutting of teeth, from constipation, from worms, and from an indigestible and undigested meal. The child suffering from a convulsion should at once be placed in the mustard bath already described and kept in it until his convulsion ceases, or until, from the reddened appearance of his skin, we think it unwise to let him remain longer. Removed from the tub, he is at once put to bed and the ice cap is applied to his head that, by its action, the supposed abnormal quantity of blood in the brain may be lessened. The cause of his convulsion must then be sought and, if possible, removed, that the trouble shall not recur. If constipation is present the soap suppository or the enema is employed. If there has been a debauch upon banana or candy, the aid of syrup of ipecac is invoked. If worms or troublesome teeth are the cause, the physician will attend to them, and if no cause can be found, we can only await the possible occurrence of another convulsion (for which the treatment must be repeated), and wonder what disease the child is "in for."

Convulsions.

Drowning causes death in either of two ways—by shock or by suffocation. In death from the former the appearance is one of pallor, while in death from the latter lividity is present, as it is in all cases of asphyxia. Notwithstanding these appearances, however, and the probability in many cases that death has already taken place, we are not justified in allowing the patient to go without an effort at resuscitating him, for it has often happened that the efforts of hours expended upon those apparently drowned have finally resulted in recovery. The following rules should be pursued in such cases: The patient having been taken from the water, the clothing over his chest should be removed, that his breathing shall be less interfered with. If the air is cold it will be wiser to withdraw the patient into a warm and sheltered place; but if this is not possible, the additional danger of exposure may be lessened by covering him with warm blankets and clothing. As rapidly as possible let the patient be turned upon his face, and, with his head hanging down, let his stomach and hips be elevated upon a pile of clothing, or something similar, that as much water as possible shall drain from his air passages. Following this he should be rolled upon his back again, and his throat thoroughly cleared and wiped of all mucus and water by the finger well covered with cloth. The tongue of the patient is then to

Drowning.

be drawn forward that it may not fall back and obstruct the throat, and artificial respiration is begun. Coincident with the performance of artificial respiration all stimulating means are to be employed, for the condition in all cases is not merely one of the failure of breathing, but of failure of circulation as well. To this end hot-water bags, hot bricks, or hot cloths are to be applied to the extremities, in the armpits, and along the inner surfaces of the thighs. Warm coverings are to be applied. Hot water containing whiskey may be given by enema, and as soon as the patient is able to swallow, whiskey should be administered internally. It may be that none of these things will be at hand, and then we must get along as well as possible with warm coverings and rubbing. These measures should not be discontinued in a less time than two hours, for, as has been said, recovery may occur only after long and persistent efforts.

Shock.

Shock or collapse is practically fainting of an exaggerated and prolonged nature. It is more often a complication of surgical injuries than it is a medical condition; but then we not infrequently have a state of shock produced purely by emotion, such as excessive joy, fright, grief, and suffering. The condition is one of pallor, with cold, clammy skin, sighing respiration, and feeble pulse. The state, in short, is that of cold limpness, and the treatment, as would naturally be inferred, is by the application of artificial heat and the free administration of stimulants.

Poisoning.

Poisoning belongs properly within this group of cases, but the subject is so important that it seems wiser to consider it under a separate heading.

Starvation.

Starvation is fortunately a condition which we are not often called upon to treat, and yet the occasion may arise at almost any time. In the relief of this condition it must always be remembered that the hunger of the patient will often lead him to eat so largely that his digestion, even if it were strong (which, because of his general weakness, it is not), would be unequal to the task, and thus produce a serious and even dangerous condition. The food is therefore to be administered in small quantities which may be frequently repeated, and the more concentrated and nourishing foods are first to be employed, such as milk and soups. The quantity of these given at one time may be gradually increased, and finally the more easily digestible solids, until, with slow progression and careful observation, the usual diet is resumed. The condition in severe cases of starvation is generally one of exhaustion, and therefore hot drinks are often required for their stimulating effect. Alcoholic drinks may be given, but caution is required in their administration to a starving man, for the danger of overstimulation is, under the circumstances, not slight.

Suffocation is the condition which results from obstruction to the en-

trance of air to the lungs. Its causes are many, and include drowning, choking, hanging, and the inhalation of noxious gases, if concentrated.

Suffocation.

The appearance is that of blueness of the face, with swollen and distorted features and protruding and bloodshot eyes. The treatment consists in the removal of the immediate cause of the suffocation, the restoration of breathing by dashing cold water (or cold and hot in alternation) in the face and on the chest of the patient, the holding of ammonia water before the patient's nose to stimulate his breathing, the performance of artificial respiration, and the use, in some cases, of the stimulating agents, heat and whiskey.

Sunstroke, contrary to the general idea, is produced not only by exposure to the heat of the sun, but to extreme heat from any source. As

Sunstroke.

predisposing factors of great importance are recognised overwork, debility from any cause, and intemperance. If a man subjects himself to the possibility of incurring sunstroke he will often experience before the onset of the attack itself certain warning symptoms, and if these are heeded it may be possible to avoid the attack. These premonitory symptoms are headache, dizziness, faintness, "seeing double," the appearance of all objects to have the same colour, a sense of distress in the stomach, nausea, and "weakness in the knees." A defiance of these warnings and a persistence in the exposure means sudden unconsciousness and—sunstroke. The appearance of one suffering from sunstroke is generally as follows: A face red and congested, laboured and noisy breathing, groaning, sometimes delirium and convulsions, a pulse which is full and strong but also very rapid, and above all things a skin which is intensely hot to the touch. The insertion of the thermometer in the patient's bowel will generally show intense fever—temperatures of 110° Fahr. are not uncommon—and still higher have been observed. In treatment the problem is to reduce the temperature without incurring at the same time the danger which intensely cold applications have of causing collapse; for this reason it will not do to place the patient in a tub of ice water, as has often been done, and expect him to survive. The treatment by all odds the best for sunstroke is to remove the patient to a cool place, to strip him naked, and then to sprinkle him with ice water, the water being discharged from an ordinary garden sprinkler held at a considerable distance above the patient's body. At the same time vigorously rub him with ice. This may appear quite as dangerous as is "playing ice-berg" with him, but it is not, for the rubbing and dropping of water on the body with considerable force from the sprinkler are highly stimulating, and it is not rare for the pulse to improve and remain good throughout the treatment. If, however, the pulse grows weak, the enema of whiskey and water should be employed. If the method recommended is followed there usually appears a gradual improvement in all the pa-

tient's symptoms until consciousness returns. One caution must ever be observed: take the patient's temperature (by the bowel) at frequent intervals during the treatment, and when it has fallen to 101° Fahr. stop, for the temperature continues to fall following the removal of the cold applications, and if these are kept up until the temperature falls to the normal point it will subsequently become subnormal and collapse will result. When the temperature has fallen to this point the patient must be put to bed, lightly covered, and an ice bag applied to his head, for there is considerable danger that "inflammation of the brain" may follow the attack. As a subsequent rise of temperature may occur, it may be necessary to repeat the bathing, though if the rise is not marked the milder remedies for fever suffice. The subsequent treatment consists of confinement to bed in a cool room and the employment of a diet which is light, unstimulating, and easily digestible. Whiskey may indeed be needed if the pulse weakens, but it is to be avoided if possible.

Heat Prostration.

"Heat prostration" is far different from sunstroke. It is simply a mild exhaustion or fainting from exposure to heat, and may result from many other causes. The treatment is rest in a cool room and the ordinary mildly stimulating treatment employed in fainting.

Caution.

In concluding this portion of our chapter let a few words of caution be expressed. Bear in mind that, of treatment, too little is better than too much, that coolness and thoughtfulness are prerequisites, and that the faintest doubt or uncertainty requires the summoning of the physician.

POISONING AND ITS TREATMENT.

Introduction.

In no class of cases is "home treatment" so important as in poisoning, for here minutes even may mean life or death, and the time lost in sending for the physician and in awaiting his arrival is often sufficient to place the patient beyond all aid. Send for the physician by all means, but do not delay the treatment for him, and above all things keep "cool," for presence of mind in these cases means everything.

Emptying the Stomach.

Though some poisons are taken by inhalation or by hypodermic injection, by far the larger number of them are taken by swallowing. If the stomach, then, can be made to eject the recently swallowed poison, its effect is lessened in proportion to the time involved. Therefore in all cases of poisoning make the patient vomit as soon as possible, and for this purpose warm water, or still better warm soapsuds, drunk in large amount and followed by the introduction of the finger into the throat offers many advantages. The value of this method lies particularly in the facts that warm water

can almost always be had; that it washes the poison from the stomach more thoroughly than do emetics given in smaller amount, and that it dilutes the poison, and therefore renders it less irritating and often less harmful. Repeat this treatment many times, that the stomach may be thoroughly washed. In the meantime let the antidote proper to the poison taken be brought as rapidly as possible, and let it be administered at once upon its arrival.

Antidotes.

Antidotes are those drugs and procedures which counteract the effects of other drugs (poisons). They accomplish this by intervening between the poison and the surface which it would otherwise affect (mechanical antidotes); by uniting with the poisons chemically and producing combinations which are harmless (they are then called chemical antidotes), or by producing symptoms the opposite of those the poison produces (in which case they are called physiological antidotes). The chemical antidote should, of course, be given as soon as possible in all cases of poisoning, if it is at hand, even before the vomiting is induced, but if not, let the stomach washing be vigorously carried on and the antidote be given when it arrives. The physiological antidote, on the other hand, must be given subsequent to the washing, since its constitutional effects are desired. Whether the antidote be used or not the stomach should be washed; for there are few perfect antidotes, and it is not safe to trust too much to the efficiency of any of them.

Poisoning may result from an overdose of almost any drug, and hence the varieties of poisoning are innumerable, but practically the dangerous poisonings, and especially those likely to be met in domestic practice, are comparatively few. These are presented in the following table, together with their prominent symptoms and their antidotes:

Poison.		Symptoms.	Antidotes and Treatment.
Strong acids.	Acetic acid. Muriatic acid or hydrochloric acid. Nitric acid. Sulphuric acid (vitriol). Oxalic acid.	Sour taste; burning pain in mouth, throat, and stomach; blistered and burned appearance about mouth: vomiting; great prostration; cold extremities; convulsions; death.	Limewater, soap, plaster (from the wall), chalk, magnesia, cooking soda (3 or 4 teaspoonfuls in a glass of water). Later, soothing fluids, like olive oil and cream; stimulants if necessary; morphine, for pain.
Prussic acid.	Prussic acid or Hydrocyanic acid. Oil of bitter almonds. Laurel water.	Large dose causes instant death; very small dose causes nausea, giddiness, rapid pulse, pain in the head, spasms, convulsions, death. Poisoning may result from smelling the drug only.	Stimulating drinks promptly and freely.

Poison.		Symptoms.	Antidotes and Treatment.
Carbolic acid.	Carbolic acid. Creosote.	Vomiting; mouth covered with white burns and benumbed; severe abdominal pain; cold, clammy skin; unconsciousness; coma; noisy breathing; odour of carbolic acid about the patient.	Syrup of lime; white of egg. Later, repeated doses of Epsom salt; morphine if necessary.
Alkalies and their salts.	Ammonia (hartshorn). Smelling salts. Caustic potash. Caustic soda. Lye. Pearlash. Saltpetre.	Burning in mouth and throat; difficulty in swallowing; severe pain in stomach; vomiting, perhaps of blood; colicky pains; may pass blood from bowels; cold skin; weak pulse; collapse; death.	Vinegar, lemon juice; olive oil freely given; fats, melted butter, cream; morphine if necessary.
Iodine.	Tincture of iodine.	Pain in throat and stomach; nausea and vomiting; prostration; cold skin; weak pulse; collapse.	Starch dissolved in water and freely given.
Silver.	Nitrate of silver (lunar caustic).	Same as ammonia.	Salt water in large quantity. Later, oil, cream, etc.
Arsenic.	Arsenious acid. "White arsenic." Fowler's solution. Paris green. Scheele's green. Green colouring matters. "Rough on Rats."	Severe pain in stomach and bowels; tenderness over bowels; retching; vomiting; thirst; hoarseness; vomited matter may be green and may contain blood; skin cold and clammy; feeble pulse; convulsions; death.	Hydrated oxide of iron with magnesia (obtainable under this name at pharmacies). Later, castor oil and olive oil; may need stimulants and morphine.
Copper.	Blue vitriol. Verdigris. Food cooked in copper vessels.	Symptoms same as in arsenical poisoning.	Milk; white of eggs in quantity. Later, oils, flour and water; morphine if necessary.
Iron.	Copperas. Green vitriol. Chloride of iron.	Colicky pains in stomach; vomiting; purging; pain in throat; cold skin; weak pulse; prostration.	White of eggs; cooking soda in water. Later, oils; morphine if necessary.
Lead.	Sugar of lead. White lead. Red lead.	Pain in stomach; cramps; nausea; vomiting; metallic taste in mouth; paralysis; convulsions; stupor.	Epsom salts, Glauber's salts freely given; stimulants and morphine if necessary.
Mercury.	Corrosive sublimate (bichloride of mercury). Vermilion.	Metallic taste in mouth; severe pain in abdomen; vomiting; purging, often of blood; irritation of the bladder; burning in throat; dulness; stupor; coma; increased saliva; death.	White of egg in large amount, if possible; otherwise, flour and water; milk. Later, sweet oil; stimulants and morphine if necessary.

Poison.		Symptoms.	Antidotes and Treatment.
Phosphorus.	Matches. In some cases suicide has been committed by eating the heads of matches. Accidental poisoning is not uncommon in children.	Pain in stomach; vomiting; purging; collapse; weak pulse; death.	Magnesia in water; soapsuds; morphine if necessary. *Oils not to be given.*
Glass.	Glass is sometimes swallowed accidentally or with suicidal intent.	Pain in stomach; purging, often of blood; collapse.	Bread should be eaten in quantity, to entangle and cover the particles of glass. Do not cause vomiting or give cathartics; leave it to Nature.
Aconite.	Wolfsbane. Monkshood.	Great weakness; cold, clammy skin; feeble pulse; numbness of lips and extremities; collapse.	Stimulating drinks with freedom.
Belladonna.	Belladonna. Atropine. Deadly nightshade.	Eyes bright, pupils dilated; face flushed, appearance as of fever; pulse rapid; dry throat; delirium; convulsions; skin hot and dry.	Morphine to point of quieting.
Strychnine.	Strychnine. Nux vomica.	Stiffness of jaws; twitchings of muscles; convulsions; ghastly grin on face.	Tannic acid; morphine to point of quieting; rest; bromide of soda; chloroform or ether by inhalation.
Chloral.	Chloral.	Dulness; sleepiness; breathing weak; pulse weak and rapid and irregular; fainting.	Stimulants. Keep patient awake.
Opium.	Morphine. Laudanum. Paregoric. Sleeping mixtures in general.	Dulness; sleepiness; stupor; pupils much contracted. even to pin point; breathing very slow (2 to 10 a minute); skin perspiring.	Strong coffee *ad. lib.*; warmth. Keep patient awake by any means, and constantly; dash with cold water; artificial respiration if breathing stops.
Vegetable poisons.	Berries. Tobacco. Horse-chestnut, etc.	Nausea; vomiting; pain in abdomen; depression; stupor; collapse.	Warmth; stimulants; morphine if necessary.
Mushrooms.	Toadstools. Poisonous mushrooms.	Nausea; pain in abdomen; vomiting; purging; thirst; convulsions; delirium; stupor; collapse; death.	Emetics; frequent doses of Epsom salts; stimulants; morphine if necessary.

The antidotes of this list are mainly chemical, but the administration of morphine, stimulants, coffee, and sodium bromide together with later treatment in general must be considered as physiologically antidotal and should follow the stomach washing.

The frequent reference to the later use of sweet oil, cream, milk, and flour and water in poisonings marked by irritative symptoms of the stomach and intestines will have been noticed, and in all such cases these soothing preparations (or demulcents, as they are called) should be given after the active treatment has been applied, that by their bland and soothing effect the inflammation of the stomach and intestines resulting from the poison shall be diminished. Indeed, these demulcents have much to do with the lessening of "after-symptoms" and the speedy and complete recovery of the patients.

THE TREATMENT OF DISEASE BY CLIMATE, MINERAL WATERS, BATHS, AND VARIOUS PROCEDURES GENERALLY CALLED "CURES."

We now come to those elaborate methods of treating disease which only concern the laity as patients and observers, for the employment and application of the means about to be described must always be left to the physician.

CLIMATE.

The effect of climatic conditions upon health and disease is a marked one; indeed, there are some diseased conditions which will yield to climatic influences alone, and many in which suitable climate is the only thing which seems in any way to benefit them. For purposes of medical classification we divide climates into dry and cold climates, moist and warm climates, dry and warm climates, high elevations, and sea air.

Dry and Cold Climates.

Dry and cold climates are generally beneficial in those chronic diseases which as yet are localized and not extensive, and in which general bodily vigour is retained. Their effect is to stimulate, to tone, and to strengthen, and they are inapplicable where weakness is present (for then they are too stimulating), and where the kidneys are diseased (for then the cold would throw too much work upon the kidneys by diminishing the activity of the skin). Of all diseases so treated, consumption in its early stages is the most prominent, and to the value of the treatment the many cures resulting from residence in the Adirondacks bear testimony. Similarly active are the climates of Minnesota and some portions of Canada and Switzerland.

Moist and Warm Climates.

Moist and warm climates, on the contrary, are not stimulating, but soothing and even weakening. If not overdone, therefore, residence in these climates will often prove of value in troubles of a catarrhal nature, for the beneficial effect of moisture and warmth upon catarrhal diseases is great. The climates of Madeira and the Canary Islands are excellent examples of this class, for they seldom suffer from cold winds and almost as seldom from hot

ones, the temperature and the moisture remaining singularly uniform both in winter and summer. They may benefit consumptives, but have a weakening tendency which, added to the exhausting nature of the disease, is sometimes injurious. Bronchitis is a disease more generally benefited.

Dry and Warm Climates.

Dry and warm climates are soothing, too, but have a less weakening effect and a marked power to increase the activity of the skin, which are due to the dryness. Of such climates Egypt offers the best example, though the south of France and parts of southern California are similarly effective. Bright's disease is much benefited by a residence in Egypt, from the effect of the dry heat in causing an activity of the skin, which thus relieves the strain upon the kidneys. Bronchitis is also improved by this climate, as is asthma.

High Elevations.

High elevations are beneficial in early consumption, but from the work such elevations throw upon the circulation, diseases of the heart are often made worse. Examples of high elevations made use of medically are seen in Colorado, the Alps, and South Africa.

Sea Air.

Sea air is beneficial in chronic bronchitis, chronic pleurisy, and scrofula, and especially if the air be had by a voyage. Early consumption, too, is benefited in some cases. Nervous diseases, however, are apt to be aggravated by sea air, whether of the ocean voyage or of the seashore, for in the sudden changes, the moisture, and the salt air, irritable nerves find too many exciting agents. Debility from overwork and conditions of convalescence from acute disease, however, are generally more benefited than are any other conditions. In fact, the effect of a voyage upon such patients is often miraculous.

Other Elements in the Cure.

In all treatments in which leaving home is required there are other factors besides the change of air; and people are too apt to forget that in such cases the air may be only one, and perhaps the least, of the good things. In aiding the good effect there must certainly be given credit to such factors as change of scene, of occupation, and of diet, and particularly to that mental condition of repose and confidence which invariably predisposes to a cure.

GYMNASTICS, MASSAGE, AND MOVEMENT CURES.

A reference to these agents is all that can be given here, for with the words on exercise contained in an earlier part of this article, as well as the contents of the article on *Physical Training*, further discussion would be superfluous. Let one thing be said, however. All animals need and must have exercise; we, as animals, are not exempt from that rule. If, therefore, our debility, save only in acute disease, prevents our taking this necessary amount of exercise for any considerable length of time, massage will not only supply its place, but by its invigorating action will, provid-

ing recovery is possible, bring about a return to muscular strength which sooner or later will restore the ability for active exercise.

HYPNOTISM.

That hypnotism is a genuine condition is beyond all doubt, but its practice has been surrounded by and associated with so much mysticism and humbug and cheap publicity that it has obtained a reputation more notorious than lofty. With recent years has come a more careful and scientific investigation into the subject, and in the hands of reputable men its position has been made more clear and its value ascertained. Yet even now it can scarcely be said that we know *all* about it.

The definition of hypnotism is not an easy one to give, but it may be said to be a condition simulating sleep, produced not by drugs, but by the moral suasion of the operator upon the operated, and during which there exists the power of perceiving things which act upon the senses, and the marked tendency to perform acts appropriate to received "suggestions."

The curious things which the hypnotized may be made to do are unlimited, and as it has been found that suggestions made to the patient while hypnotized may even operate after his awakening from this state, this has been taken advantage of in the cure by "hypnotic suggestion" of various symptoms, and especially those of a hysterical nature. That this treatment has been effective is undoubted, but scarcely permanently, and certainly no more reliably than many other moral agents employed against hysteria. There seems reason to believe, too, that the effect of this hypnotization may be harmful, and especially if practised upon the nervous and intellectually mediocre. Amateur hypnotization, therefore, can not be too strongly condemned, and the practice should be left to the experienced physician.

MINERAL WATERS.

The waters of mineral springs are employed in medicine both for internal administration and for bathing, and though the former does not require a residence at the spring—since many of the waters are bottled and exported—yet the full benefit of treatment is in that case not experienced. Nothing mysterious or "occult," however, is required to explain the inferior efficacy of the bottled mineral water, for the water itself is in no way responsible for the difference, but simply the factors already alluded to under climatic treatments—namely, change of scene, life, diet, physician, and favourable mental conditions. In many cases, indeed, these factors should be credited with the larger part of the success in cases of cure.

Various classifications of mineral springs are made, but no elaborate

arrangement is necessary for our purposes, and a few words upon the more important and common ones is all that we contemplate.

The Alkaline Waters.

The alkaline waters are the commonest which are used medicinally, and, though as baths they are of little benefit, their internal administration is often valuable in chronic catarrh of the stomach, chronic diseases of the intestines and liver, gout, gall-stones, and those conditions which are said to be caused by "acidity." In wasting diseases and in anæmia the alkaline waters are injurious. The alkaline class is a very large one, for it includes all those whose marked constituents are alkalies, but the greatest variation among them exists both as to the quantity and kind of the prevailing alkali. Of simple alkaline waters many of those of Saratoga and Carlsbad are excellent examples. In some of the alkaline waters bitterness is a more pronounced characteristic, and hence the "bitter waters" are a subdivision of the alkaline class. Of bitter waters Hunyadi is a familiar example.

Salt Waters.

The class of alkaline waters includes some of a taste so salt that they have been called "salt waters," but their employment is generally for the effect of the alkalies they contain, and when we speak of "salt waters" we usually refer to waters the principal mineral ingredient of which is sodium chloride or "salt." Of this class sea water offers the best example, though, strictly speaking, the two classes of salt waters which we have made differ each from the other quantitatively only. The salt waters are usually more employed for bathing than for internal administration, and thus used their effect upon scrofula, chronic joint diseases, and chronic diseases of the skin is often good, especially if the temperature of the water is warm. Of salt-water springs so used are those of St. Catharines Wells in Canada, and some of the Saratoga waters.

Sea Bathing.

Sea bathing is salt-water bathing undeniably; but other elements enter into its curative activity, the factors of value being the cold, the salt in the water, the motion of the waves, and the sea air, together, of course, with the change of habits and the amusement, generally accompaniments of life at a "watering place." The especial value of sea baths is seen in those debilitated from over-work and those likely to "take cold." In convalescence from acute disease it is valuable, but is to be forbidden to those in whom debility is marked or in whom congestive disease exists.

Hot Springs.

Hot springs furnish waters which are generally more efficient for bathing than for drinking. Their employment by this method is of considerable value in chronic skin diseases, rheumatism, gout, and neuralgia. The hot springs of Virginia and Arkansas are the most familiar examples of this class.

Sulphur Waters.

Sulphur waters are generally also alkaline, and the larger part of their beneficial effects, if taken internally, is probably due to this fact. If administered by bathing, however, it is probable that their ingredients are of little value, and, though they may be either hot or cold, the hot ones are the more effective. In fact, it is probable that any effect these waters may have as baths is due, not to sulphur, but to heat. Examples of sulphur waters are found at Richfield and Sharon, in New York, and the White Sulphur Springs of Virginia. The cases supposed to be benefited by these waters are chronic rheumatism, gout, and nervous diseases, and while the drinking is thought to benefit chronic catarrhs the bathing is considered especially good for chronic skin diseases.

Lithium and Iron Waters.

Lithium waters (popularly called "lithia waters"), if natural, are practically of no use, since no natural lithium water contains enough lithium to be of benefit unless drunk in quantity almost impossibly large. The application of lithium is in gout, and it is far wiser and more practical to give the drug itself rather than the best of "lithia waters." Iron waters are about as useless as lithium waters, and for the same reason—they contain so small a quantity of iron as to be medicinally of little value.

Arsenical Waters.

Natural arsenic waters are known, but their value is slight so far as the arsenic is concerned, because the amount of that drug present in them is infinitesimal.

So many elements enter into the success or failure of treatment by mineral waters that it is certainly unjust to ascribe all benefits as due to the mineral they contain. Some of these factors have already been mentioned, and in conclusion it may be said that water itself, without mineral contamination, is a medicine of no small effectiveness, and this whether it is drunk or applied to the skin; and, furthermore, that warm water is especially valuable in the very conditions in which warm mineral baths are supposed to be so effective; and, finally, that the mineral-water business is a great field for humbug.

BATHS.

A consideration of bathing in health and in acute disease has already been given, and mineral-water baths have necessarily been included in the general consideration of mineral waters; it remains, therefore, to complete the consideration of baths by the brief presentation of a few remaining curative procedures to which the name is more or less appropriately applied.

The Turkish bath is simply an exposure to dry heat in a series of rooms of which the temperature is artificially raised, the temperature of the coolest being about 120° Fahr., while the temperature of the hottest

may be even 250° Fahr. Into these rooms, beginning with the coolest, the naked patient walks, the result being that excessive perspiration soon results. After a variable time the patient is rubbed, and concludes his bath by a cold spray, cold needle bath, or cold plunge. He is then dried and usually lies about for a while in a warm room and wrapped in a light covering. The effect of the bath is to deplete the system and to promote fluid exudation from it. It is thus valuable, as has been said, in obesity, but is no substitute for the more rational treatment laid down for that condition. The bath acts also to remove those ailments due to exposure to cold, such as muscular rheumatism and bronchitis, and is effective here, as is the "sweat." The immediate effect of the bath is stimulating and invigorating, and hence by many it is taken occasionally for these pleasurable effects. The effect of the excessive heat, however, is sometimes to produce palpitation of the heart and even fainting, and therefore the Turkish bath is not allowable for those suffering from diseases of the heart or blood-vessels.

The Turkish Bath.

The Russian bath is similar to the Turkish bath save that the heat is not dry but moist, the rooms containing steam. The moisture present thus acts to prevent the cooling effect of evaporation of perspiration on the patient, and thus in the Russian bath no such high temperatures can be borne as in the Turkish bath. Its effects are similar, however, with the added value that moisture and warmth have in catarrhal diseases of the respiratory passages.

The Russian Bath.

The immersion of patients in various mixtures and "messes" has from time to time been practised by enthusiasts and others less sincere, the idea being that the ingredients of the "bath" would exert a specific and healing action upon various diseases. As a matter of fact, no such action takes place, and though benefit, indeed, may result, it is from the action of the heat and moisture present, and the value of these has already been considered. It is not necessary to describe these procedures, for their names carry with them all necessary information. The class includes mud baths, pine-needle baths, herb baths, sand baths, tan baths, and malt or bran baths. And for a supposed nutritive effect—which is utterly absurd, for no absorption takes place—there have been used, for the poorly nourished and debilitated, soup and milk baths.

Mud Baths, etc.

TREATMENT BY RAREFIED OR COMPRESSED AIR.

In some diseases, especially those of the lungs, the patient is made to breathe air the pressure of which is different from the ordinary atmosphere. This is performed in one of two ways. The first is that in which his whole body is surrounded by the (usually) compressed air, and in this case the treatment is referred to as the "compressed-air bath." The effect of breathing in this com-

Compressed Air Bath.

pressed air has been found good in some cases of asthma, chronic bronchitis, and sometimes in consumption. The other method is that in which only the pressure of the respired air is changed, the atmosphere surrounding the patient being of the normal pressure. The usual method of this application is for the pressure of the air breathed in to be increased, while in breathing out the patient breathes into air of which the pressure is lowered. The result of this treatment is that inspiration becomes more deep and expiration more complete, and thus, with an expansion of lung capacity, more oxygen is taken into the system and more waste products (especially carbonic-acid gas) are thrown off. The diseases thus treated are, in general, those treated by the compressed-air bath. Occasionally the air used in these compressed-air methods is medicated, in the expectation that thus the healing drug will more perfectly and completely reach and act upon the diseased surfaces.

"CURES."

To say that a treatment is a "cure" would primarily seem high praise or the height of sarcasm and sneering. Neither of these is intended to apply to the subjects to be considered, for the word "cure" is here used for want of a better one, meaning system of treatment. The word, therefore, is rather a convenience than an accurate description, and so far as a sarcastic meaning is concerned and an intimation of "quackery," it suffices to say that the treatments here considered are legitimate, well recognised, and generally excellent.

The Milk Cure.

The milk cure consists in putting the patient on a diet composed exclusively of milk, and, that the intolerance likely to arise from such monotony may not occur, the quantities are at first small and the administration frequent. The treatment owes its value to the bland, soothing, easily digestible, and nourishing qualities of milk. The treatment may be persisted in for several weeks, and is often very effective in cases of ulcer of the stomach, dyspepsia, and Bright's disease.

The Whey Cure.

The whey cure is now little employed, though it was formerly popular. Whey is that portion of milk which remains after the "curd" has been removed, and consists of water, milk-sugar, a little fat, and mineral salts. It is medicinally equivalent to a mild mineral water, and was thus used; but as a matter of fact it presents few advantages over the water and has the marked disadvantage of causing dyspepsia and indigestion, a result for which the sugar it contains is responsible.

The Grape Cure.

The grape cure is practically the same thing as the whey cure, for the remedy consists of water, salts, and sugar. Several pounds of grapes are taken daily, and in cases of obesity some benefit is probable from the laxative effect produced by the grapes.

The treatment, however, presents no advantages over that by mineral waters, and is open to all the objections made against the whey cure.

Mountain Climbing.

Oertel's treatment of diseased hearts by mountain climbing is rather surprising, in that it prescribes an exertion which had previously been supposed injurious in such cases. His views would appear sound, and certainly his treatment is often effective. Briefly described, its action is as follows: By active exercise perspiration is increased and thus the bulk of the blood is lessened. This diminution of the blood results in a lessening of stagnant blood in the body, which is generally an accompaniment of heart disease, and that drinking may not replace the fluid thus lost the treatment requires the taking of less drink. Furthermore and most important, the exercise, by increasing the force and rapidity of the heart action, causes the heart muscle to enlarge and gain strength just as any muscle will grow if regularly exercised. The amount of exercise, of course, is so regulated, gradually increased and alternated with rest, that the danger from overstrain, always a great one in disease of the heart, is avoided.

The Rest Cure.

The "rest cure," which is sometimes described as the Weir Mitchell treatment, from its introduction by Dr. Mitchell, is not merely a treatment by rest, but one in which several prescribed factors participate. These, in Dr. Mitchell's own words, are "a combination of entire rest and of excessive feeding, made possible by passive exercise obtained through the steady use of massage and electricity." The cases in which the treatment is applicable are those of nervous, hysterical women in whom nutrition is deficient, and its success is certainly remarkable. Especially is this so when we consider the defiant nature of such conditions—conditions so obstinate to treatment, indeed, as to make these patients the bane of the physician.

Space does not suffice for a full and minute delineation of the Weir Mitchell treatment, but a little amplification of the definition given is necessary to a comprehension of the subject. The patient placed upon this treatment is removed from home, and, save for the presence of her physician and her nurse, is absolutely isolated. No books are allowed, no work, no letters, nothing save treatment to break the absolute monotony. Ordinarily she is required to remain continuously in bed, and even the "sitting-up" position is forbidden. Then she is fed, and fed, and overfed with nourishing materials, and at regular intervals massage and electricity are given. This absolute seclusion, regularity, rest, and monotony are marked features of the method, and though it would perhaps seem that to take a nervous woman from the sympathy and loving attentions of her home and to subject her to such treatment is cruel, yet this view is but a part of the sentiment which keeps these patients sick, for the surest proof of the value of the plan is its success, while the effect of

pampering and petting and coddling the hysterical is undeniably to make them worse. The effect of the treatment is to reduce the patient practically to the condition of a vegetable, and she lies there without occupation, diversion, or motion, until from very necessity the unused brain and nerves sleep, and in sleeping regain their power. According to the progress of the case the restrictions are gradually and carefully relaxed, until, with the return of nervous tone and vigour, the invalid is permitted, step by step, to return to her every-day life.

XIII.

NURSING THE SICK.

By ANNA CAROLINE MAXWELL.

CHAPTER I.

CHOICE OF THE SICK-ROOM.

CARE OF THE SICK-ROOM, INCLUDING HEATING AND VENTILATING.

The Sick-room.

The points to be kept in mind in choosing the sick-room are sunshine, pure, fresh air, and freedom from noise and odour. To obtain a maximum of the former and a minimum of the latter, the family are often put to great inconvenience and an extra amount of labour. This is especially true in cities, where only the upper stories of dwelling houses are provided with sunlight, and in apartment houses, where the darker rooms are often used for sleeping. In these cases either the top of the house or the best room in the apartment has to be chosen. The room should have, if possible, an open fireplace and a southern exposure, thus taking advantage of the greatest amount of sunlight and favouring winds. It is important that the sick-room be kept free from odours of a pungent nature, such as highly-scented soaps, perfumery, and certain flowers that affect the sick unpleasantly.

Decorations and Furniture.

Plain walls, or those decorated with paper of subdued colour and pattern, are most pleasing to the eye and produce a soothing effect. It is a well-known fact that the mind of a delirious patient is often disturbed by a wall paper of gaudy design and colour, or by a picture of startling or pronounced character.

Without seeming to make too much disturbance, unnecessary articles of furniture and heavy drapings that obstruct the free entrance of sunlight and air should be removed. Rocking chairs should invariably be banished on account of their disturbing qualities. When sitting in one of these chairs it is almost impossible to avoid rocking, and their motion often makes an invalid nervous and irritable while unconscious of the cause. A still further objection is the fact that, upon getting up suddenly

from them, the back may strike against some other article of furniture, thus causing noise or breakage.

An easy chair should be left to be utilized when the patient first sits up, and a small table is essential to stand at the bedside upon which to place the food tray, keep a bell, or any small belongings of the patient. A second table is useful for writing, as all orders of the physician should be written down and notes of the patient's condition kept. There is a bedside table made especially for use in the sick-room, which extends over the bed in front of the patient. It is supported by an upright at one end furnished with a spring by means of which it can be raised and lowered to suit changes of position. The foot piece attached to the upright extends under the bed, thus giving balance to the table and preventing its upsetting.

It is often necessary for the one in charge of the nursing to sleep in the sick-room, and some provision for this purpose has to be made. Although most of the modern sleeping rooms are furnished with a sofa or couch of ample dimensions that may be made to answer in place of a bed, they are seldom long enough to admit of a person lying at full length. The cot is therefore the most convenient and easy arrangement. It is inexpensive, light, and quite as comfortable as a single bed, and can be folded and placed out of sight in the daytime for economy of space. It can also be used by the patient. Being nearly the same height as a bed, it is easy to have him moved on to it; and during convalescence, when change of scene is desirable, it can be easily carried to other parts of the house.

The Bed.

The ideal bed for taking care of a sick person is one made of iron—either single or three quarters in size—provided with a woven-wire spring and hair mattress. This bedstead, with woven wire mattress, can be purchased for a comparatively small sum. The double bed so universally used will answer, but can not be made as comfortable. The mattress is apt to sink in the centre on account of its width, and it is almost impossible to keep the under sheet drawn tightly enough to prevent wrinkles. A hair mattress should be used in preference to one made of any other material. Feathers are especially objectionable on account of the warmth and moisture created by them, and the impossibility of making the bed properly when it is occupied.

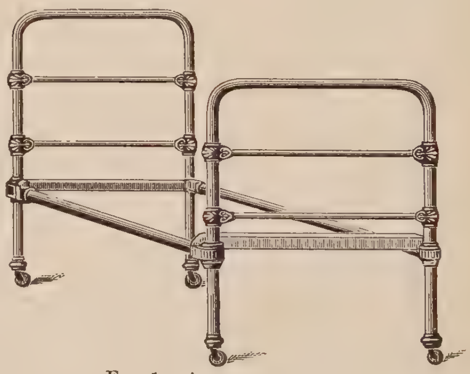


Fig. 1.—An iron bedstead.

Making the Bed.

In making a bed the mattress should first be covered by a sheet tightly stretched from side to side and tucked firmly in as far as possible on all sides under the mattress. Another sheet folded lengthwise and carried across the centre of the bed should also be drawn tightly and tucked in at either side. This is called a *draw-sheet.* It should extend well up under the pillows, as it serves to keep the bed firm, and to cover the rubber sheet when one is necessary

FIG. 2.—METHOD OF CHANGING THE BED OF A HELPLESS PATIENT.

to protect the mattress. The top sheet, with each succeeding blanket, should be tucked in separately and firmly. The spread should be of dimity or some light texture, a sheet being preferable to a spread of heavy weight.

Single blankets are more desirable than double ones, as they admit of the introduction of air between the layers. Cotton sheets are best for ordinary use, the linen ones being used when great radiation of heat is desirable.

The bed should be placed so that the light will fall from behind rather than in the eyes of the patient, and free from the walls so that access to all sides is possible. Freedom from direct draught must also be considered, and sometimes screens have to be used permanently where the windows are inconveniently placed.

In changing the bed of a helpless person, or one who is very ill, the greatest care must be taken not to cause unnecessary disturbance, and in extreme cases a second person should be called to assist. (It is well to give a little beef tea or hot milk before beginning, when the patient is very weak, as it will enable him to bear the change better.) The fresh linen should be thoroughly aired and warmed and everything in readiness. When possible the patient should be turned on one side; the soiled sheets are then loosened and rolled closely to the back of the patient, the roll (Fig. 2) being placed next to the mattress. The clean sheets rolled together to their centre are then placed just under the edge of the other roll, and the loose edges tucked as far under the mattress as they will admit. The patient is then gently turned on the other side over the roll, the soiled sheets removed, and the clean ones tucked firmly and tightly into place. The object of turning the roll downward next to the mattress is to prevent its disarrangement, and also to facilitate grasping the roll when the patient can not be entirely turned over it.

Changing the Bed of a Helpless Patient.

In changing the top sheet the spread and one blanket should be removed first, and over the remaining blanket should be placed the fresh sheet. The discarded blanket or a fresh one is then placed on top of the clean sheet and tucked firmly about the shoulders of the patient, or else held in place with one hand while the soiled ones are drawn out at the foot or side of the bed. The remainder of the bed is then completed in the usual manner.

Another plan by which the bed can be changed is that of folding the sheets back and forth in fan-shape, as given in the accompanying illustration (see Fig. 3), instead of rolling them. This makes a flatter surface under the patient, but it is difficult to get the folds even on account of the length of the sheets, and they are much more liable to become disarranged. Still another way is to gather the sheets tightly in a fluffy roll and place them at the back of the patient, as previously described. These methods are useful when the patient can help himself, but the first mentioned is by far the most practical and satisfactory when the patient is helpless.

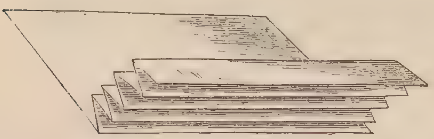


FIG. 3.—THE CLEAN SHEET.

When changing the personal clothing the soiled garments should be pulled well up under the shoulders and slipped over the head, and the arms removed last. The clean clothing is then substituted by reversing this order, and should be pulled down smoothly under the back. When it is necessary to change the bed and the patient's undergarments at the same time, the

Changing Personal Clothing.

latter should be changed first to avoid crumbs being left in the fresh bed.

The greatest possible comfort is derived from fresh linen and fresh pillows, and as an economy it might be well to keep two sets in use, letting one set air while the other is in use. If there is scarcity of linen the fresh sheet should be put on below, next to the patient, rather than above.

Changing the Mattress.

In acute diseases, when the mattress becomes soiled or uncomfortable, and in paralysis or any case in which there is constant evacuation of the bowels, involuntary passage of urine, or excess of perspiration, it becomes necessary to change the mattress. If this is not done a very disagreeable odour will be produced, and in time the materials of the mattress will become decayed. If the patient be very ill, helpless, or very heavy, four people, two on either side of the bed, will be required to accomplish this change without injurious disturbance. The bedclothes should be untucked at all sides, the patient moved to the edge of the bed, the clothing rolled firmly up to him, and the side of the mattress on which he is lying pulled to the centre of the bedstead. The fresh mattress is partially doubled and placed alongside the soiled one, and the patient lifted by the bedclothes on to the fresh mattress. The soiled one is now removed, the other drawn into place, and the patient lifted to its centre. The sheets are then tucked in place, and the bed made up as previously described.

Noises.

Noises are to be avoided, not only in the sick-room, but in other parts of the house where they are liable to disturb the patient, and if they occur the cause should be removed as soon as possible. Unexplained sounds, or sounds of a startling nature, are the ones most irritating to the nerves. Rattling window shutters have to be removed, as their noise can not be overcome in any other way, and in their absence the light can be controlled by tacking a piece of dark cambric inside the window frame. When the windows rattle they can be wedged apart between the sashes with pieces of wood, matches, a folded newspaper, or a pair of scissors.

Regard for the Patient's Sensibilities.

The attention of the patient should always be attracted before addressing him, as he may be startled and a nervous attack brought on by being spoken to suddenly from behind. Great care should be taken not to jar the patient by striking against the corners of the bed in passing. It should always be remembered that the bed is sacred to the patient, and should not be leaned against, sat upon, or joggled. Whispering, always a discourtesy, is not so intended when brought into the presence of the sick, but it does disturb them by awakening them when asleep or by irritating them when awake.

The best method of heating a sick-room is by an open fire; either coal or wood should be used. The English cannel coal is preferred on account of its freedom from dust. In removing ashes from the grate they may be sprinkled to prevent flying, and should be shovelled up quietly. The fire must be noiselessly replenished. In using coal it can be prepared in little paper bags outside the room and placed on the fire without disturbing the patient.

In cleaning the room, dissemination of dust is to be avoided. If there is a carpet on the floor and the patient can not be removed from the room, it should be swept by using a damp whisk broom and the dustpan, and going over it afterward with a damp cloth, being careful to avoid too much moisture.

Ventilation.

True ventilation consists in keeping the air of the room as pure as the air outside; this can be accomplished quite easily in several different ways. The best means of constant ventilation is through an open fireplace, a current being created in winter by the fire. In summer this may be accomplished by placing a lighted candle or lamp inside the chimney. Window ventilation is best carried on by double windows with double sashes. The lower sash of the outer window is raised about two feet and the inner upper sash lowered about the same distance. This allows of a constant passage of air directed upward, thus preventing a direct draught upon the patient; or the ordinary windows can be raised and lowered top and bottom even with the woodwork, allowing of about an inch space of ventilation between the sashes. Another plan is to tack a piece of cotton about four inches wider than the window, and twelve inches in depth, to the top of the upper sash. The upper corners of this cotton can then be tacked to the window frame and the window lowered to the extent of about one foot. The air as it passes in is directed toward the ceiling, in addition to the current between the sashes. A still further method is to raise the window by the introduction of a board fitted to the opening, the air passing in and out between the sashes. When there are two windows in the sick-room—and if possible this should always be the case—the upper sash of one should be lowered and the lower sash of the other raised, draughts being prevented by the measures previously taken or by screens.

In modern buildings heating and ventilating is carried on by propulsion and extraction of air by means of fans. This method is very expensive, and has not yet reached perfection.

When possible the entire air of the room should be changed at least twice a day, but this should never take the place of the constant introduction of air in small quantities.

In certain diseases it is necessary to have the air warmed before it comes in contact with the patient. This should be done by opening the

windows and heating the air in an adjoining room before it passes into the sick-room. The corridor or bath room should never be used for this purpose, the objection being the dangers of contamination with sewer gas and impurities from the kitchen and sleeping apartments.

CHAPTER II.

CARE OF THE PATIENT.

It is essential to the well-being of the patient that one member of the family be chosen to have entire charge of the sick-room, including the carrying out of the physician's orders. When it is necessary for her to have relief for hours of rest and recreation she should leave *written directions* concerning treatment, food, and medication, so that during her absence no mistake can be made. These directions should be so minute as to include even the position the patient should maintain (for example, the recumbent or upright), and should be adhered to strictly. Rest and recreation are necessary to the performance of good work, and it is not kindness on the part of those caring for the sick to go for days and nights without proper rest or without undressing. If long hours are unavoidable, a cold bath with change of garments gives great refreshment and sharpens the faculties. In diseases of long duration, especially in those that may at any time become critical, the strength of the person undertaking the duty of nurse should be in a measure reserved for this emergency, as change at such a time may result seriously. If the patient be conscious it is undesirable to introduce new faces, and if unconscious, the stranger, not understanding his individual habits, might be unable to make him take nourishment or submit to treatment.

One Person in Charge.

The dress of the one in charge of the patient should be of cotton or some washable material, and the greatest possible care should be exercised in regard to change of personal clothing, bathing, and disagreeable odours of the breath so often due to indigestion, or neglect of the teeth.

In learning to lift it is important to stand firmly, to balance the body well, and to stand as erect as possible. The firm, careful grasp, showing strength and power, imparts a feeling of confidence and reassures the patient. Avoid using the ends of the fingers, or sticking the nails into the flesh, as this causes pain and irritation. Use, instead, the balls of the fingers, making the hand as flat as possible. Do not be afraid of hurting an infant when lifting him. A baby prefers to be lifted with decision, and objects to noth-

Lifting and Handling.

ing so much as the lack of it. It is a curious fact that he is always afraid of falling, as shown by the startled way in which the hands are thrown up and the frightened look upon the face. This feeling of fright is soon overcome by taking him up as one would a bundle of clothes, firmly and gently, and holding him without fear. The left hand is the better one to use, three fingers supporting the head and neck, while the shoulders are held by the thumb and little finger. In this way the body of the infant lies along the arm and the whole is well supported before leaving the bed.

When a patient has slid down and needs to be lifted up in bed, one hand should be placed under the shoulders, the other under the thighs, and the invalid carried gently upward. If he be heavy or very ill, and motion is undesirable, two persons, one on either side of the bed, should do the lifting as above described. If the patient be on a double bed and needs changing to the other side, the bedclothes should first be loosened all round and rolled firmly up to him. Two persons should then kneel on the mattress on opposite sides and lift the patient by the bedclothes, moving him over by walking on the knees, one forward and

FIG. 4.—METHOD OF LIFTING PATIENT FROM ONE BED TO ANOTHER.

the other backward. This sounds much harder than it really is, for, if care be taken to have the knees freed from the skirts, it is a comparatively easy matter.

When it becomes necessary to change a sick person from one bed to another, the beds can be placed opposite and parallel to each other about five feet apart (Fig. 4), the head of the fresh bed on a line with the

foot of the occupied bed. Two people standing on the same side of the bed can lift the patient by putting the hands of one under the shoulder and buttocks, the other under the thighs and ankles, and by keeping the patient flat they can readily turn half round and place him gently on the new bed. When the patient is very ill, or of very heavy weight, three people should help in the lifting, and if they all stand on one side and lift in perfect unison, the patient will hardly be conscious of any movement.

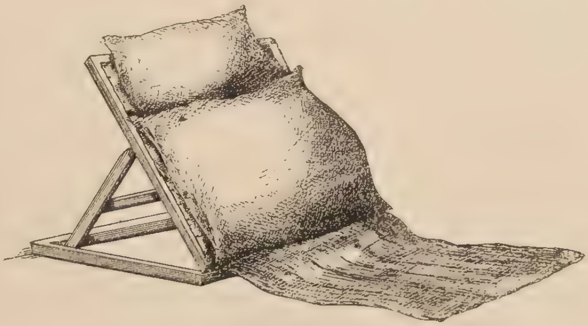


Fig. 5.—A back rest.

In raising a patient's head for medicine or nourishment always place the hand under the pillow and see that the head is well supported. As a preparation for sitting up, and in cases where the recumbent position is hurtful or impossible, a back rest should be used, as shown in Fig. 5. A great variety of these are to be had both in shape and construction, some being made entirely of wood, while others have the framework only of wood with canvas stretched across. They are inexpensive, and are the most comfortable means of propping up an invalid in bed. A very good substitute is a straight-backed chair turned upside down. A back rest with arms that rest upon the bed is very useful in cases of heart disease; or when for any reason the patient has to maintain the upright position constantly, it furnishes support to the arms, and if the patient needs to lean forward for relief and change of position, a board well padded can be placed across in front of him for this purpose. Plenty of pillows should be provided, and, if possible, one of hair should be placed first well under the back, so that the patient can sit upon it, and each succeeding one so as to form an incline of any degree that is comfortable. It is important that the head should be well supported, as a patient who has been lying flat for some time is apt to feel weak and often dizzy upon having the head raised for the first time.

The Back Rest.

There are a number of "lifters" or appliances intended for the comfort of the sick, and to save the strength of those in attendance. The simplest form of these that can be introduced into the sick-room is the crane, as seen in Fig. 6. This crane may be attached to the wall or to the frame of an unused door, and the bed so placed that the arm swings in front of the patient. By this

The Crane.

means he can change his position easily and help in lifting himself. Many other appliances are to be had. Some are arranged with canvas that can be slipped under the patient and attached to hooks suspended from pulleys in the ceiling by which the lifting is done. These appliances are useful for chronic invalids, but not for those suffering from acute disease.

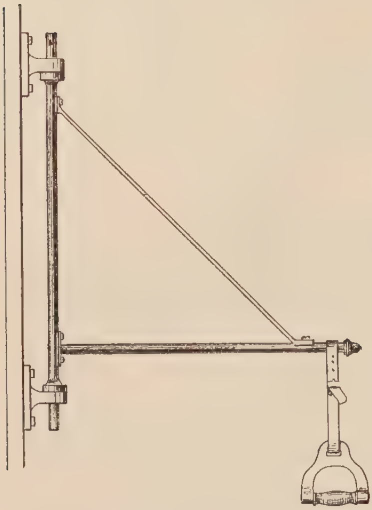


Fig. 6.—A crane.

The great value of rest can not with impunity be underestimated. All Nature has its periods of rest. The organs of the body are so constructed that they have their periods of compulsory rest as well as those of compulsory work, the heart, for example, in the intervals of its beats, resting about nine hours in every twenty-four. This brings us to the greater question of complete rest both of mind and body, so important to the building up of impaired tissue.

Rest of Mind and Body.

There is little doubt among thinking people that the mind has a most powerful influence upon the tissues, and that anything that tends to keep the mind at rest, free from worry and excitement, tends to restore the condition of health. Let it be, therefore, the first thought of the person in charge of the sick to remove, as far as possible, all minor causes of worry; to adapt herself to the idiosyncrasies of the patient, standing always between him and any cause for alarm or irritation. Extreme quiet, lack of haste in manipulation, gentle methods of performing the small offices, garments that do not rustle, noiseless shoes, etc., tend to soothe and produce the desired quieting influence upon the mind.

Rest of the body can be accomplished in a variety of ways: by frequent change of position, by the use of small pillows of different sizes (one of the refinements of nursing), or by larger pillows and sand bags used to give support and fixation. A given position, essential to recovery from disease or from an important surgical operation, becomes irksome and hard to bear, making the patient restless and often sleepless. In such cases the greatest relief can be afforded by placing these small pillows under the shoulders, the hollow of the back, or under the knees or ankles, and removing them at intervals. This gives change and rest to the muscles, and cools and refreshes the different parts of the body. If both knees need support at one time, a hair pillow can be doubled through its

length and placed firmly under them. This relieves all strain from the abdominal muscles, and can also be used when the joints of the knees are affected. Other joints can be similarly supported or kept perfectly quiet by placing pillows on either side. Small bags made of ticking and filled with sand are most useful for keeping an extremity immovable. Painful joints should be disturbed as little as possible, and when they have to be moved should be lifted with great care and without bending. If an injured extremity has to be moved, grasp it firmly near the joints and carry it in the direction of its most natural movements.

Light.

It has already been stated that light should be admitted from behind a patient, and if the headboard of the bed be not solid, a shawl or rug can be thrown over it to subdue the light. More objectionable than light shining directly in the face are streaks of light coming in at the sides of the window shades. They annoy and irritate the patient, and are very injurious after inflammation of the eye or operations upon the eye. Such streaks can be overcome either by pinning the shade to the window sash with a strong shawl pin or covering the window entirely with dark cambric.

CHAPTER III.

METHODS OF GIVING BATHS.—TEMPERATURE.

Before beginning a bath all the articles necessary for use should be brought together, and in cold weather the room should be made warm and comfortable.

Sponge Bath.

Sponge baths, whether for cleansing or cooling purposes, require that the bed be protected either by a rubber sheet covered by an ordinary sheet, a thick blanket, or a heavy Turkish towel. When given for cleanliness, soap, towels, and a large basin or foot tub are required. The face and hands are washed first. One portion only of the body is exposed at a time, and this portion, after being well dried, should be carefully covered, unless the body temperature is high, in which case there is no danger of the patient's taking cold. The patient should be guarded against fatigue by giving the bath rapidly, without haste, and turning the body as little as possible.

A sponge bath for the reduction of temperature is given by first sponging over the body rapidly with warm water from 80° to 90° Fahr., followed by a slow sponging (long strokes being used) with water, to which alcohol and ice are sometimes added. Alcohol and ice are added

only by the physician's order. This bath may be continued for twenty minutes, and the cooling process carried still further by leaving the body uncovered and fanning the patient briskly for ten or fifteen minutes, till thorough evaporation of heat has taken place.

Foot Bath.

When the foot bath is to be given in bed, the bed should be protected by a covered rubber sheet, the foot tub, half full of water, placed in the bed, the knees flexed, and the feet raised with one hand under the ankles while the tub is drawn under them with the other. The knees and tub are then covered with a blanket. The feet should be thoroughly rubbed after removing them from the bath, and an extra blanket used to keep up the heat produced by the bath. Very hot water or mustard added—two tablespoonfuls to the ordinary foot bath—will increase the revulsive action.

Full Tub Bath.

A full tub bath requires that the tub be filled three quarters full, so that the entire body is enveloped in water. The patient can be protected by a sheet while the bath is being given, so that no exposure of the body is necessary. The sponging and rubbing can be done perfectly well under the sheet, and a warm, dry sheet put over the bath tub before taking the patient out. The duration of the

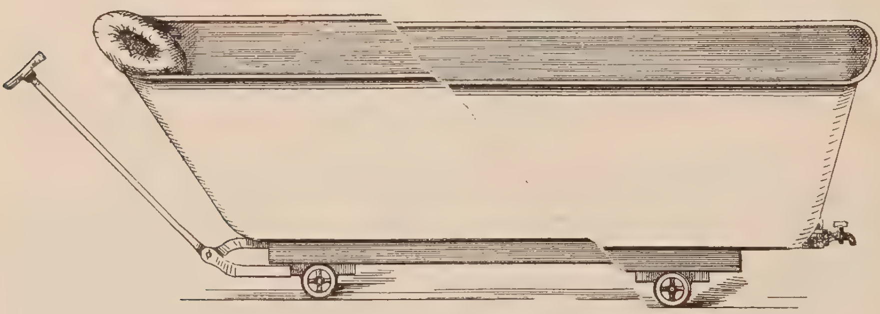


Fig. 7.—A portable bath tub.

bath should not exceed ten minutes. Warm towels give the greatest comfort when drying the patient. A bath that acts favourably should produce a warm, healthy glow upon the skin after rubbing.

Brand Treatment.

In carrying out the "Brand treatment" for the reduction of temperature in typhoid fever (as described in the article on *Medicines and Treatment*) it is necessary to have a portable bath tub that can be wheeled to the bedside, and to have the patient lifted very carefully and by persons strong enough to hold him firmly and steadily. Stimulation should be given both before and after the bath—whiskey or hot milk. There are two ways of putting the patient into the tub: either by lifting him over the side of the tub or moving him down in a straight line, having the tub placed at the foot of the bed.

A rubber ring should be used to give support to the head, and a sheet stretched across the tub for the shoulders to rest upon, as indicated in Fig. 7.

It is important to give plenty of friction especially to the spine—*surface* friction, constant but light—and avoid rubbing too heavily, as the skin becomes tender, and this often makes the giving of the baths painful and almost impossible. After the bath heaters are applied to the feet. In most cases the patient is covered only by a sheet, that the evaporation of heat may not be interfered with. Great care must be exercised in disinfecting the hands of those who have given the bath, as carelessness may result in infection.

Sitz or Hip Bath. The "sitz" or hip bath is given in a tub made expressly for the purpose, about fourteen to eighteen inches deep, with a high back, to give support to the shoulders. This tub should be filled only one third with water, to prevent its flowing over when the patient sits into it. A blanket is pinned about the patient's shoulders, enveloping the tub as well, and by this means keeping in the heat.

The temperature of the bath should be equalized throughout its duration by removing some of the water and adding that which is hot. The "Davidson bulb syringe" is used for this purpose, the water being pumped out and in. The usual duration of this bath is from twenty to thirty minutes, and the desired temperature will be ordered.

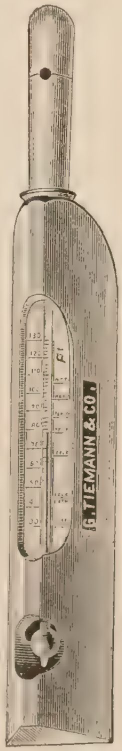


FIG. 8.—A BATH THERMOMETER.

The average standard temperatures for baths are as follows:

Cold........	33°–65° Fahr.	Tepid......	85°– 92° Fahr.
Cool........	67°–75° "	Warm......	92°– 98° "
Temperate...	75°–85° "	Hot........	98°–112° "

Bath thermometers are to be had partially inclosed in a plain wood frame to protect them against hard usage and to bear the action of water (Fig. 8). The ordinary atmospheric thermometer can, however, be used just as well.

CHAPTER IV.

THE PREVENTION AND TREATMENT OF BEDSORES.

A BEDSORE is gangrene or death of a part; the immediate cause, shutting off the circulation of the blood from the tissues. This condition may be brought on very readily unless prompt preventive measures are used, when the body is greatly emaciated, the circulation poor, or when the position is such as to cause constant pressure on a given area. The parts of the body most liable to be affected are bony prominences, as the lower part of the spine, the shoulder blades, the heels and the elbows, and the fleshy portion of the hips in very heavy people unable to be turned. With children, lying constantly upon the back, especially if there be incessant movements of the head, the back of the head is most commonly affected. The symptoms apparent to the patient, if conscious, are heat of the part, a pricking sensation, redness and roughness of the skin, and pain on pressure.

Causes and Symptoms.

In diseases where there is predisposition to bedsore—as, for example, in typhoid fever and in cases of impaired circulation—the back should receive attention from the very beginning of the illness. Moisture, wrinkles, and crumbs are the commonest enemies to be combated. Moisture softens the skin; wrinkles and crumbs irritate and roughen it. The presence of moisture is most often due to the accumulation of perspiration from the body, or of discharges either from wounds or from the bowels or bladder. Frequent changes of linen, pads made of oakum or jute placed in old muslin or cheese cloth, or large sheets of Japanese paper that can be readily burned, are useful for receiving such discharges. Wrinkles are most often present because the under sheet is not drawn tightly enough. The draw sheet previously described is perhaps the most valuable aid in preventing them, its length being greater than the width of the ordinary sheet, holds firmly when carried well under the mattress, and can be changed readily. Crumbs have a persistent tendency to fall into the sick-bed despite all efforts to prevent them. The fault lies in allowing them to remain, causing irritation and excoriation of the skin. A small whisk broom proves a very efficient means of removing them, but this will never take the place of the human hand. A thorough search should be made after each meal, and not one should be allowed to remain. Position, or rather changes of position, by which pressure is relieved, are perhaps of the greatest importance. Air pillows, folded sheets, pillows made of hair, rubber rings covered with bandages to prevent moisture on the surface, rings made of batting or

Treatment.

sheet wadding wound with bandages (Fig. 9), are used. These rings can be made to fit any part of the body, from a tiny one small enough to prevent pressure upon the ear to one large enough to support the buttock. These are placed so as to prevent pressure upon bony prominences or to raise the body from the bed. When there is extreme weakness and a tendency to lie constantly upon the back the patient can be turned gently on one side by placing one hand under the shoulder and the other under the buttocks and drawing them forward; a pillow folded lengthwise so as to form a wedge can then be placed well under the back for support. This can be done first on one side then on the other. It gives great relief and comfort, and often prevents the much-dreaded bedsore.

FIG. 9.—A COTTON RING.

Extreme cleanliness is of the utmost importance. The parts most liable to pressure should be washed daily with soap and water and rubbed frequently with alcohol to cleanse and toughen the skin. A powder composed of equal parts of oxide of zinc and starch or talcum powder is useful when applied sparingly to the irritated skin. Avoid using too much powder, as it may form cakes upon the surface and do injury rather than good. A preparation of equal parts of collodion and castor oil painted over the surface forms an artificial skin and sometimes prevents a breaking down of the tissues.

CHAPTER V.

METHODS OF TAKING THE TEMPERATURE, PULSE, AND RESPIRATION.—BEDSIDE NOTES, ETC.

THE object of taking the bodily temperature is to ascertain the heat of the blood. The instrument used is the so-called "clinical thermometer." These thermometers vary in delicacy, the finest ones registering the temperature in one minute, others in from three to five minutes.

The more expensive ones magnify the scale. The Hicks thermometer is probably the best. In taking the temperature it is the aim to place the thermometer within a closed cavity from which the external air is excluded. The mouth, the armpit, and the rectum furnish the best cavities for this purpose, the rectum being surest when any question of inaccuracy arises, or in cases in which the circulation of blood on either side of the body differs. This last method should always be employed with children.

Temperature.

Before using the clinical thermometer the mercury should be shaken below the normal point, $98\frac{4}{10}°$ to 95°. Avoid shaking it entirely into the bulb, as this will prevent future self-registration. If the temperature is to be taken by mouth make sure that no very hot or cold fluids have been recently used; place the thermometer under the tongue at either side, where the blood-vessels lie; instruct the patient to keep the tongue well down over the bulb and the lips firmly closed till the time expires. When the armpit is used, all moisture should be removed and the thermometer placed against the chest with the bulb well embedded in the armpit; the arm is then folded across the chest and held in place by the other arm, and the patient constantly watched that the thermometer does not slip down. When the temperature is taken by the rectum, ascertain first if the rectum is free; otherwise an enema should be given, and the taking of the temperature delayed half or three quarters of an hour till the former heat has returned. When the temperature is found to be unusually high or unusually low, it should be taken over again and, if possible, a duplicate thermometer used, to prove that there is no inaccuracy in the thermometer itself. The temperature is sometimes ordered to be taken every hour in certain cases, as when baths or medication for its reduction are employed; otherwise it may be taken every four hours, or twice daily—at about eight in the morning and five in the evening. It will probably be found to be lowest in the early morning. A thermometer is less liable to be broken when in constant use if kept in a small glass or wide-mouthed bottle with cotton in the bottom.

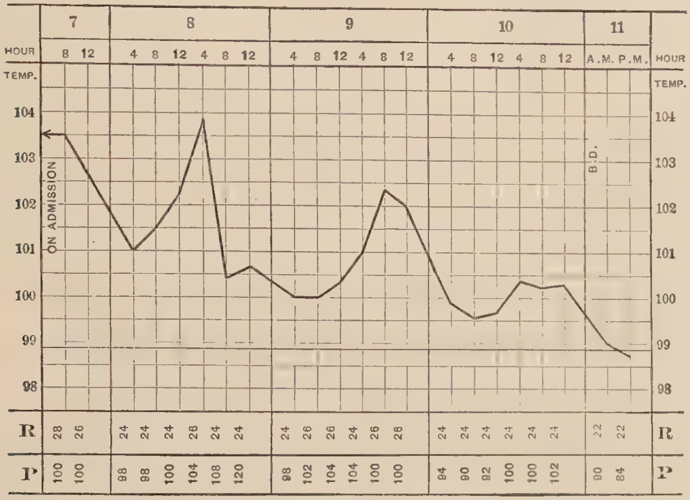
The pulse—the index to the heart action—may be taken at any point where the arteries are superficial. The most convenient points are the thumb-side of the wrist, the temple, the side of the neck, and the top of the foot. In learning to count the pulse it is probably best to count through the whole thirty seconds and afterward to count by the quarter, or by tens. A thorough knowledge of the pulse is to be gained only by study, unlimited experience, and constant practice.

Pulse.

The respiration is taken by watching the movements of the chest as it rises and falls upon inspiration and expiration. This is best done while still holding the wrist, as if taking the pulse. The attention of the

TEMPERATURE CHART.

NAME *John Doe.* DATE *September 17, 1895.*



BEDSIDE NOTES.

NAME *John Doe.*

DATE.	HOUR.	MEDICINE.	URINE.	DEJ.	REMARKS.	DAY OF DISEASE.
June 1st.	7 P. M. 1 A. M.	℞ Whiskey ℥ ss., every 4 h., 4, 8, 12. ℞ Strychnine gr. $\frac{1}{30}$, every 4 h., 4, 8, 12. ℞ Typhoid precautions. Fluid diet. ℞ Tub bath, 80°, 15 min., every 4 h., for temp. 102·5 or +.	8 P. M. ℥ x 11·30 P. M. ℥ viii	2	Admitted to ward 6 P. M. Temp., 102·5°; pulse, 92; resp., 24. Cleansing bath given. Patient complained of headache.	
June 2d.	7 A. M. 1 P. M.	℞ Typhoid precautions. ℞ Fluid diet. ℞ Tub bath, 80°, 15 min., every 4 h., for temp. 102·5 or +. ℞ Whiskey ℥ ss., stat. and every 4 h., 4, 8, 12.	10 A. M. ℥ vii 6 P. M. ℥ x	1	11·40 A. M. Temp., 104·4°; pulse, 96; resp., 22. Tub bath. Stood bath at 4 P. M. well. Slight shivering for 10 min. after bath. Low delirium and muttering at intervals during the day; somewhat restless.	
		Total, 24 hours....	℥ xxxv	3		

TOTAL

NURSE

patient is attracted toward the pulse, over which he has no control, and the respiration remains unchanged; otherwise the attention has to be drawn to other things and valuable time is lost.

Respiration.

To make a record of value the temperature, pulse, and respiration should, if possible, be taken about the same hours daily. A chart for keeping the record is given on the preceding page, but a simple method giving the hours, etc., by figures is useful when charts are not to be obtained. Notes of the condition of the appetite, the skin, the mouth, the excretions from the bowels and bladder, the amount of sleep, etc., can be kept either by noting these points on a sheet of paper, or having a chart or notebook expressly for this purpose.

CHAPTER VI.

MEDICINES AND THEIR ADMINISTRATION.

Various Methods of Medication.

There are a number of avenues through which medicine can be introduced into the system, thus finding its way by absorption into the blood, and through this medium, in most cases, to the organs or tissues to be affected. The first and most important of these avenues is the stomach. This, however, sometimes fails to retain and absorb drugs, and they have to be given by rectum. The absorption through the stomach is slow, and that by rectum still less rapid; and when time is an important factor, as in the relief of severe pain or heart failure, the method of introducing medicine under the skin by a hypodermic syringe has to be resorted to. When the lungs and throat are affected, medication by inhalation through an atomizer or steam kettle has to be instituted. An ordinary tea kettle, with stiff paper twisted into cone-shape, so that it will fit well over the mouth and be attached to the spout, can be used, or a canopy can be made over the bed to keep in the steam. An alcohol lamp is necessary to keep the water boiling, and this can be placed between the bricks upon which the kettle is to stand. Local applications to the skin and mucous membrane can be made by means of ointments, liniments, lotions, etc.

Most alcoholic stimulants, with the exception of wines, should be diluted about one half. Cough mixtures, composed of substances which are intended to form a coating along the mucous membrane and allay irritation, should never be diluted. Oils can not be diluted with water. They should be given in some vehicle to disguise the taste—for example, hot coffee or milk, beer, Vichy, soda water—or they can be given with lemon, brandy, or whiskey. Other bad-tasting drugs can be inclosed in

gelatin capsules or wafers that are readily dissolved by the juices of the stomach, or the sense of taste can be deadened by the use of ice or something pungent, like peppermint, brandy, or whiskey. Iodide of potassium can be given in milk or well diluted with Vichy. Effervescing drugs, like Seidlitz powder, should be given in a large glass of water, allowing most of the effervescence to pass off before it is taken. Powders that can not be dissolved should be given dry on the tongue and washed down with fluids. Pills, unless freshly made, should be pulverized and given in jam or bread crumbs. Many of the compressed tablets so universally used are often unaffected by the digestive tract and should usually be dissolved or broken up before being given.

Drugs.

Cheap or stale drugs are to be avoided, as disease is often prolonged by their failure to relieve the symptoms for which they are given. Choose always a trustworthy chemist rather than a cheap one. Medicine not in use should be discarded; chemical change, due either to excess of light, heat, or cold, may take place, or the drugs may become stronger by evaporation, thus making them unsafe for use. Prescriptions used for any particular disease seldom contain the necessary combinations for another, and should not be kept.

Bottles.

All bottles containing drugs should be distinctly labeled and the label *read twice* before giving. Poisonous drugs should be kept in blue bottles with rough exterior, that the touch may call attention to the fact. Never, under *any* circumstances, allow an incorrect label to remain on a bottle even for a few minutes. *Failure to label poisons has caused many deaths.*

Measuring Medicine.

Medicine should be measured accurately, if possible in a graduated glass marked for the purpose (Fig. 10). If the teaspoon or tablespoon be used instead, remember that the medium-sized teaspoon answers to the drachm (sixty minims), and the ordinary tablespoon to four drachms, or half an ounce. Drops of different drugs vary so much in size that it is always well to use the minim measure. The glass should be held on a level with the eye when measuring. In this way the marks can be seen better and the exact amount insured.

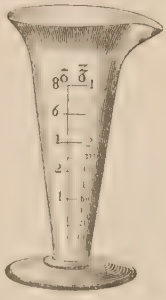


Fig. 10. The peerless graduated measure.

There are few general directions about the giving of medicines to be laid down except that *the orders of the physician are to be carried out implicitly almost without exception*, that the medicine is to be made as pleasant to the taste as possible, is never to be measured in the presence of the patient, and should be given without discussion. If carried to the bedside

quickly and the head raised, the patient will often take the dose almost without thinking about it. If medicines are ordered to be given before meals they are probably intended to influence the gastric juice and act as an aid to digestion, and they should be taken half an hour before eating. Those ordered to be given after meals may be of an irritating nature, and their action less felt when food is still present in the stomach; they should therefore be given half an hour after meals. Other forms of medication have the desired effect only when a certain amount has accumulated within the system; such medicines are often given in small, frequently repeated doses, every hour or every two or four hours, because of the danger of upsetting the stomach by larger quantities. These medicines, as well as those intended for the relief of pain, should be given promptly as ordered. Indeed, it might be said that all doses ordered should be given except when the stomach is greatly irritated or upset by them, and in this case the physician should be communicated with early.

Administration of Medicine.

The small glass holding from two to four tablespoonfuls is most useful for administering medicine. Spoons or tubes are objectionable to many people. The small glass, not over half full, can be managed readily. The head should be lifted gently on the pillow without bending the neck, in such a way as not to cause any constriction on the throat, and the medicine can be swallowed with ease. If the patient is partially unconscious, moistening the lips will often attract attention and make him swallow. The glass medicine tube, flattened at one end and bent about three inches from the end, to adapt itself to the chin, is necessary when iron is given, to protect the teeth. Oil or medicine that imparts a disagreeable odour should never be given in a glass used for other purposes.

CHAPTER VII.

FOODS AND FEEDING.

General Considerations.

It is impossible in an article so limited to enter into the classification of food and its value, or to give an adequate idea of the important part it plays in the repair of tissue waste in the body. This is a much-neglected field in general education. One of the greatest signs of the advancement of civilization is that the "chemistry of food" and the "chemistry of cooking" are beginning to be more generally taught to the young. The proverb that "Man is either a fool or an epicure at forty" should no longer hold true.

He should have learned his lesson before he is twenty. Then, too, a knowledge of the right quantities of proper material for physical development is important. How many an impaired digestion can be traced to overfeeding as an infant, or a stunted growth due to improper or underfeeding!

In health Nature generally demands the foods most needed to build up the tissues and supply waste; but in sickness the taste and appetite are not always trustworthy guides. It often happens that the foods that have pleased most in health can not be endured when sickness comes, or that the desire for food is entirely absent. The sense of smell often becomes more acute, and inhaling the odours of certain foods or of the breath of the person administering the food, may be the occasion for its rejection. The use of any perfumery while tending the sick is to be avoided, for its odour is very apt to cause distaste for food in a sensitive invalid.

Administration of Food.

In administering food to the sick there are a few general principles important to bear in mind: First, that a little food well tolerated, digested, and assimilated is far better than the larger quantity that irritates and obstructs by its bulk; second, that this food must be of the best quality, prepared without destroying its nutritive properties, and made toothsome without overseasoning; third, that it must always be presented in a dainty and attractive manner. Many devices to aid in the toleration of food have to be resorted to when the stomach is irritable—*i. e.*, the addition of lime water, Vichy, or Apollinaris to milk, giving milk and eggs under cover of other names (milk "jelly," milk "sherbet"), somal (koumiss in siphons), egg soup, raw egg made cold and flavoured with wine (wine *frappé*), egg in coffee, or frozen beef juice flavoured with lemon, etc. These foods should be given either very cold or very hot and in small quantities often repeated—a teaspoonful every hour or half hour, or even half that quantity. There are also aids to digestion in the form of predigested foods, milk, beef, etc.

Cooking.

The quality of the food should be of the best: milk, eggs, and oysters above reproach; beef and game well seasoned, but free from taint; vegetables fresh from the garden, etc. In the cooking, care must be taken to preserve the juices of the meat, to have the farinaceous foods thoroughly cooked through, and to avoid too high seasoning. As a rule, sick people prefer more salt and less sugar. When the largest amount of nutritious substance is to be obtained from meat (extracts, broths, etc.) the meat should be set to cook in cold water and not allowed to boil, as this coagulates and destroys the albuminous portions of the meat. Food cooked in small quantities retains its flavour better. It should never be given when over- or under-done or burned. Infinite pains should be taken also with the cooking utensils

and the refrigerator in which food is kept. *They should be kept scrupulously clean and free from odour.*

Fluid Diet.

Fluids should be served from a small glass brought on a tray with a dainty fresh cover, and with a napkin used to prevent spilling on the bedclothes and to wipe the mouth afterward. Feeders (Fig. 11) should be employed only when the head can not be raised. The glass tubes (Fig. 12) are generally unnecessary.

In feeding a patient unable to be lifted, the head should be turned slightly on one side and the fluid given slowly and in small quantities, to prevent choking and too great fatigue. If there is difficulty in swallowing, pinching up the throat gently just on either side of the windpipe will often accomplish it.

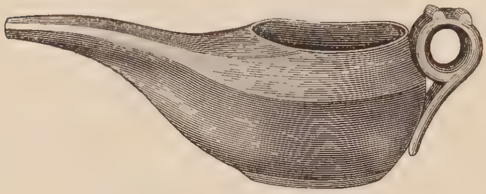


FIG. 11.—A PORCELAIN FEEDING CUP.

FIG. 12.—A GLASS FEEDING TUBE.

While the diet is confined to fluids, it should be given at regular intervals, and a strict account kept of the amount taken. Three pints of milk (the most complete form of food we have) or its equivalent is the amount essential to sustain life for twenty-four hours. Of course there are exceptions to this rule, but many times the sick have suffered seriously from being underfed.

Solid Foods.

The more solid foods should be served in small quantities, separate dishes being used; and when the variety is limited, it is well to serve in courses. The linen must be fresh, the china, silver, and glass of the best the house affords, and spotlessly clean and shining. A flower or bunch of green adds much to the appearance of the tray, and the dress of the person presenting it should be immaculate. A bed tray with small feet to stand on the bed without resting on the chest (Fig. 13) is a great convenience and saves the strength of the patient.

When the appetite is poor, the sight of a large quantity of food brought to the bedside is upsetting; a portion should always be kept out of sight and brought forward gradually, if possible, without the knowledge of the patient. When the patient is being fed solids the food should be cut in small pieces and plenty of time allowed for mastication. A small amount of fluid should be given at the time of eating, as a large quantity taken into the stomach at this time undoubtedly interferes with digestion.

Special diet in the present day enters so largely into the treatment of most acute and many chronic diseases that it may be well to call attention

to the necessity of rigid adherence to the plan laid down by the physician. In certain diseases (diabetes, for instance, being the most commonly known) sugar acts as a poison to the system, increasing the severity of the disease and diminishing the patient's chances of life. In this case all foods containing an appreciable amount of sugar or starch which is convertible into sugar are prohibited, or in the case of an ulcerated or diseased stomach the foods that are digested largely by the intestines and tax the stomach least are given, and in case of intestinal disturbance just the reverse—those that are digested entirely by the stomach being used. A diet composed entirely of starchy foods, gruels, arrowroot, rice, tapioca, etc., should never be given, as many cases may be cited where both children and adults have been literally starved by strict adherence to this form of food. The nitrogenous principle, even in the smallest quantity, must be introduced.

Special Diet.

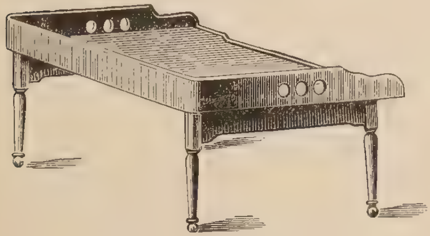


FIG. 13.—A BED TRAY.

In these cases it becomes almost an art to present the few articles of a limited diet in such an attractive manner that they are not always recognised as the same, or to overcome a morbid distaste for food in any form and keep the patient properly nourished. In chronic diseases of long standing this task becomes even more arduous, and yet a little thought and attention to the details will accomplish wonders.

In the first acute stage of almost any disease it is important that nourishment be introduced in condensed form and in a condition that puts the least possible tax upon the digestive organs. This suggests the predigestion of foods, and milk and beef lend themselves most readily to this process.

STERILIZED MILK.

Sterilization of milk is best accomplished with the Arnold sterilizer, as shown in Fig. 14. The bottles, which fit into a light frame, each contain eight and a half ounces. They are to be boiled and then filled with milk to within half an ounce of the top, plugged with cotton, absorbent or plain, and put in the sterilizer. The base of the sterilizer is filled with hot water, placed over a gas or ordinary stove and boiled for forty minutes. The steam thus generated rises through

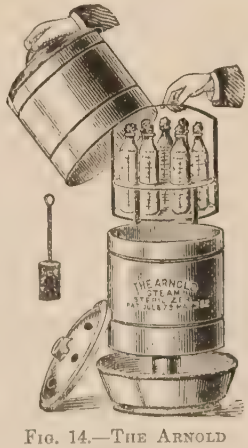


FIG. 14.—THE ARNOLD STERILIZER.

the perforation in the base of the steamer, and the milk is thoroughly sterilized. As a substitute for the Arnold sterilizer, a kettle or clothes boiler may be used with straw or excelsior in the bottom on which to place the bottles.

PEPTONIZED MILK.

Milk may be peptonized by the cold or warm process, and is supposed to be equally well predigested in either case. The cold process, being the simpler, is generally employed: To one pint of fresh milk add the contents of one of Fairchild's peptonizing tubes dissolved in warm water. (This tube contains five grains of pancreatic extract and fifteen grains of bicarbonate of soda.) Then place the bottle in ice for half an hour, remove, and keep in a cool place. Warm process: Heat the milk to 180° Fahr. and add the contents of the tube dissolved in water; then place the bottle for fifteen minutes in a pail of water at the boiling point. It should then be placed immediately upon ice to check the peptonizing process.

KOUMISS.

Heat one quart of perfectly fresh milk to 90° Fahr., add one third of a two-cent cake of Fleischmann's yeast and one tablespoonful of sugar, cork tightly, tying the cork down, and let it stand twelve hours in a temperature of 75° Fahr. Shake thoroughly and keep on ice. Five days are required to complete thorough fermentation.

SOMAL.

Another form of fermented milk is known as "somal," and can be procured in siphons. It has the advantage of being sterilized. "Somal" keeps perfectly till the whole bottle is consumed.

BEEF JUICE.

Broil a piece of round steak an inch thick for seven minutes, squeeze the juice into a hot cup with the lemon squeezer, and season with salt and pepper.

BEEF TEA.

Beef tea is valuable for its stimulating properties and for the warmth that it gives; it is also somewhat nutritious, containing, as it does, the albuminous juices of the meat, some salts, and the very important flavours. Beef tea should be prepared in such a manner that the juices are held in solution in the water, not coagulated, to secure which the cooking temperature should never be allowed to exceed that of 160° Fahr.

To make *bottled beef tea*, put into a large-mouthed bottle one pound of beef free of fat and chopped fine; add half a pint of cold water; let it stand one hour; then place the bottle in a saucepan of cold water, put

it on the fire, and heat the water slowly almost to the boiling point, *but do not let it boil.* Cook for two hours, then strain and season with salt.

The thick sediment which falls to the bottom when the tea stands awhile is the most nutritious part. It is to keep this sediment (the albuminoids) in a soft digestible condition that care is taken not to let the water that surrounds the bottle boil, as great heat hardens the albuminoids. For the sake of variety (if the patient tires of beef tea), change the flavour occasionally by adding a piece of cinnamon an inch square to the meat and water.

Bottled beef essence is made in the same way as the above, only omitting all water. It can also be made by standing the jar in the oven for three hours instead of cooking over the fire.

For *economical beef tea*, cut one pound of juicy round steak into small pieces and add one cup of cold water. Let it stand several hours. When ready to serve, squeeze the meat over a bowl, strain the juice obtained, add salt to taste, and heat just enough to make it palatable (not enough to curdle). Serve at once.

If heated directly over the fire it must be stirred constantly and taken off the moment it looks thick and is hot. The better way is to heat it carefully over hot water.

Add another cup of water to the scraps of meat and soak again. Often the third cup of tea may be made from the same meat. Beef tea is *excellent in cases of great exhaustion.*

To make *frozen beef tea*, set a small tin pail or can in a wooden pail and surround it with salt or crushed ice, and be very careful the salt does not get into the tin pail. Put cold beef tea into the pail and let it stand ten minutes. Then take off the cover and scrape the congealed beef tea from the sides. Beat well and put back the cover. Do this two or three times and the tea will be frozen smooth. This is intended for patients who must have their food cold.

NUTRITIOUS BEEF BROTH.

Take three pounds of solid beef from the shoulder or shin, and three pounds of bone from the same. Remove the dried skin and any soft or bloody portions. Cut the meat into small pieces and put it, together with the cracked bones, into an earthen jar. Cover it with four quarts of cold water, set in a slow oven, and cook from eight to twelve hours. Strain through a colander, add two teaspoonfuls of salt, and cool quickly. When cold, skim off the fat, and serve cold as jelly; or heat to 170°, but not above 180°, as boiling injures its value.

BOUILLON.

Take a dilute solution of gelatin and salts of meat flavours, of about half the nutritive value of the broth; two quarts of the cold beef broth. Beat the white of an egg just enough to break it, crush the shell, and add both to the cold liquid. Mix well, heat slowly, and let boil ten minutes, then stand at the back of the stove for half an hour. Remove the scum, and strain. If allowable, the bouillon may have added to it, when put on to clear, two tablespoonfuls of chopped vegetables, turnip and carrot, one teaspoonful of onion, an inch of stick cinnamon, and a blade of mace.

CONSOMMÉ.

Take a dilute solution of gelatin and salts of meat flavours, three pounds of lean beef and three pounds of the knuckle of veal. Cut the meat into small pieces and crack the bones. Add to them four quarts of cold water, two teaspoonfuls of salt, one onion, one small carrot, one small turnip, a blade of mace, an inch of stick cinnamon, three cloves, a sprig of thyme, the same of sweet marjoram and of summer savory, and a bay leaf. Cover closely and let simmer on the back of the stove for eight hours. Strain and set it away to cool. When cold, it is clear like bouillon. Season and serve.

MUTTON BROTH.

Weigh two pounds of the neck of mutton, cut it into small pieces, crack the bones, cover it with two quarts of cold water, heat very slowly and let simmer three hours, or cook in a double boiler for five or six hours. When the meat has been cooking two hours add two ounces of rice and, if desirable, a small onion. At the end of three hours remove the meat, season and serve. Unless it can stand overnight to cool, skim off the fat when it first comes to a boil, and again after putting in the rice. Veal and chicken broth are made in the same way.

CHICKEN BROTH.

Free one half of a young fowl of skin and fat, wash it, and cut it into small pieces; put in a stewpan with one quart of cold water; place on the fire and heat slowly to the boiling point; then skim carefully and set it back where it will simmer three hours. Season with salt and strain.

If the patient can take tapioca, sago, or rice, add one tablespoonful to the broth after it has been cooking one hour.

CLAM BROTH.

Take six large hard-shell clams washed well with a brush. Put them into a kettle with two or three tablespoonfuls of water over the fire. As

soon as the clams open they are sufficiently cooked. More cooking will only make them tough. The broth does not require any seasoning, as the clear juice is salt enough; it has sometimes to be diluted with hot water to reduce the salt flavour. This broth is as much a standard dish now as beef tea. It can be retained on the stomach when other food disagrees with the patient, it is a valuable substitute for milk when that can not be taken, it is nourishing and stimulating, and can be given by the teaspoonful in cases of severe illness, or by the cupful to convalescents.

OATMEAL GRUEL.

Pound one half a cup (two ounces) of coarse oatmeal in a mortar until it is mealy, then put it into a tumbler and fill the tumbler up with cold water. Stir and pour off the mealy water into a saucepan. Fill up the tumbler again and pour off, and repeat as long as the water looks mealy. Set the saucepan on the back of the stove and let it simmer at least one hour, or cook in a double boiler two hours. Strain, season with salt, and serve. Thin with milk or cream if too thick.

INDIAN-MEAL GRUEL.

Blend two tablespoonfuls (one ounce) of Indian meal in a little cold water and stir into one quart of boiling water. Boil on the back of the stove two hours. Salt to taste, sweeten, and add milk if desirable. Strain and serve.

FLOUR GRUEL (WITH MILK).

Mix one ounce, or two tablespoonfuls, of flour with a little cold milk and stir into one quart of boiling milk. Cook in a double boiler two hours, or on the back of the stove in a saucepan. Salt to taste. Strain and serve. Sweeten if desired.

BARLEY GRUEL.

Blend one ounce, or two tablespoonfuls, of barley flour (Robinson's) with a little cold milk and stir into one quart of boiling milk. Cook in a double boiler two hours. Season with salt to taste, and with sugar if desired. Strain and serve.

RICE GRUEL.

Blend one half ounce, or one tablespoonful, of rice flour into a little cold water. Turn into one quart of boiling water and cook in a double boiler until transparent. Salt to taste. Sweeten and add milk if desired. Strain and serve.

Flour and arrowroot gruel may be made in the same way.

RECIPES FROM VARIOUS SOURCES.

ARROWROOT.

Take one tablespoonful of arrowroot, one saltspoonful of salt, one teaspoonful of sugar, one cup of hot water, and one cup of milk. Wet the arrowroot with the salt and sugar in two tablespoonfuls of cold water, then pour on the hot water, stirring constantly; boil it for twenty minutes, then add the milk and bring just to the boiling point. Strain and serve immediately.

RENNET.

Take one half pint of fresh milk heated to 100° Fahr., add one teaspoonful of essence of pepsin, and stir just enough to mix. Let it stand till firmly curdled. It may be served plain or with sugar and grated nutmeg.

WINE JELLY.

Take one quarter of a box of Nelson's gelatin, one quarter of a cup of cold water, one and one quarter cup of boiling water, one half cup of sugar, one half square inch of cinnamon, one clove, and one half cup of sherry wine. Put the gelatin and cold water together in a dish large enough to hold the whole mixture, let it soak for half an hour, and pour the boiling water in which the clove and cinnamon have been simmering over the softened gelatin; add the sugar and wine and stir until the sugar and gelatin are perfectly dissolved, then strain through a fine napkin into a granite-ware basin and cool in a refrigerator or in a pan of iced water.

ORANGE JELLY.

Take one quarter of a box of gelatin, one quarter cup of cold water, one half cup of boiling water, one half cup of sugar, one cup of orange juice, and the juice of half a lemon. Soften the gelatin in the cold water by soaking it for half an hour, then pour in the boiling water as previously directed until the gelatin is dissolved; add the sugar, orange juice, and lemon juice in the order in which they are given; stir for a moment, then strain the liquid through a napkin into moulds and set it to cool. Use earthenware or granite-ware moulds, not tin.

The point most to be observed in making this jelly is getting the juice from the oranges. The most natural way would be to cut the oranges in halves and squeeze them in a lemon squeezer; but that will not do, for the orange oil of the rind is extracted in such large quantities as to destroy the delicate flavour of the jelly. The proper way is to peel the fruit, cut it in pieces, put it in a jelly bag, and squeeze out the juice with the hand.

CHICKEN JELLY.

Clean a small chicken, disjoint it, and cut the meat into small pieces; remove the fat, break or pound the bones, and put all into cold water, using the following proportion: a pint for every pound of chicken. Heat the water very slowly at first, and then let it simmer until the meat is tender, three or four hours being required. Boil down to one half the quantity; strain the jelly and remove the fat; then clear with an egg and season with salt, pepper, and nutmeg or lemon. Strain through a fine napkin, pour into small cups, and cool. Parsley, celery, and bay leaves give a good flavour. A suspicion of red pepper is also an addition.

BEEF SANDWICHES.

Cut slices of bread (a day or two old) as thinly as possible. Cover the slices with scraped raw beef, salt, and cut into squares one inch thick or into diamonds. Butter can be added if allowed.

BROILED BEEF PULP.

Scrape raw beef to a pulp, make it into small cakes, and broil as steak. Season with salt, a few grains of Cayenne pepper, and serve hot.

BROILED SWEETBREADS.

Parboil and split the sweetbreads, season with salt and pepper, rub thickly with butter, and sprinkle with flour. Broil them over rather a quick fire, turning constantly; cook about ten minutes and serve with cream sauce.

CREAM SAUCE.

Take half a pint of cream, one half a generous tablespoonful of flour, salt and pepper to taste. Let the cream come to a boil. Have the flour mixed and smooth, with one half cup of cold cream (reserved from the half pint), and stir it into the boiling cream. Add the seasoning and boil three minutes.

CHICKEN SOUFFLÉ.

Chop half a cold chicken, cooked and freed from skin and bones, as fine as possible; pound in the mortar, then rub through a sieve. (The white meat is best.) Place in a saucepan a piece of butter the size of a pigeon's egg, and when it bubbles stir in with an egg whisk a dessert-spoonful of flour. When evenly blended stir in three quarters of a cup of hot water and let it cook a few minutes, stirring smoothly together with the egg whisk. Then stir in the chicken pulp and season palatably with salt and Cayenne pepper. Let the paste get entirely cold (covering it so that it will not get hard), then mix into it lightly first the yolks of

two eggs beaten to a cream, then the whites of three eggs beaten to a stiff froth. Put into paper cases or small pudding cups. Bake about fifteen minutes in the oven, and serve as soon as done.

SHIRRED EGGS.

Butter small earthen dishes (one for each egg), put an egg in the dish without mixing the white and yolk, dust a little pepper and salt over it, then place upon the back of the stove or in a moderate oven until the whites of the eggs are set; the dishes are sent to the patient and the eggs eaten from them. If the eggs be put in the oven, cover with buttered paper to keep them from browning.

CREAMED POTATOES.

Cut cold boiled potatoes into cubes one third of an inch thick; put them into a shallow pan; cover with milk (or half milk and half water). Cook until the potatoes have absorbed nearly all the milk. Add to one pint of potatoes one tablespoonful of butter, one half teaspoonful of salt, one half teaspoonful of pepper, and one teaspoonful of chopped parsley.

CREAM OF ASPARAGUS.

Cook half a bunch of asparagus and one small onion in one quart of white broth half an hour or until the asparagus is done. Remove the onion, strain, and rub through a sieve; put back on the stove. Blend two tablespoonfuls of milk and two tablespoonfuls of flour, add to the soup, and cook fifteen minutes. Then take from the fire and beat in one tablespoonful of butter, and at the last minute add half a cup of hot cream. Season to taste with salt and pepper.

CREAM OF BARLEY.

Moisten half a pint (eight ounces) of well-washed barley with one quart of white broth, add one small onion, and cook one hour. Season with half a tablespoonful of salt and one saltspoonful of pepper. Strain and thicken with one cup of cream and the yolks of two raw eggs.

Cream of rice may be made in the same way.

DRIED FRUIT SOUP.

Weigh one half pound of dried peaches, wash until perfectly clean, and cook in one quart of water till very soft. Strain and squeeze out all the juice. Sweeten to taste and serve.

Soup may be made from any of the dried fruits in the same way.

PANADA.

Sprinkle a little salt or sugar between some crackers (Boston, soda, or Graham, or hard pilot biscuit); put them in a bowl; pour over them

just enough boiling water to soak well; put the bowl in a vessel of boiling water and let it remain fifteen or twenty minutes until the crackers are quite clear and like a jelly but not broken. Lift carefully into a hot saucer. Sprinkle on more sugar or salt, whichever is liked, and add a few spoonfuls of sweet cream or wine if it be allowed. Never make more than enough for one time, as it is very insipid when cold.

CHAPTER VIII.

ENEMATA. SUPPOSITORIES. DOUCHES. CATHETERIZATION.

The Rectum and Intestine.

In the normal adult the rectum (the lower part of the bowel) lies to the left of the spinal column, curving inward and upward (Fig. 15). The length is about eight inches, and it is lined with mucous membrane that has the power of absorbing partially digested food. Above the rectum the intestine is curved somewhat like the letter S, and it is in this curvature that fæcal or refuse matter (a product of the food) accumulates and

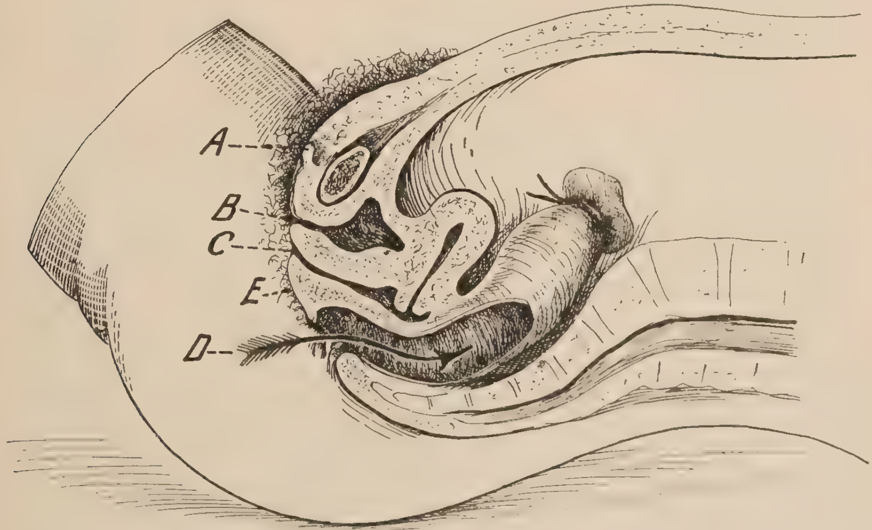


Fig. 15.—The curve of the rectum.
A, the pubic bone; B, the bladder, C, the vagina; E, the perinæum; D, the rectum.

becomes impacted. Still higher up, at the junction of the small and sometimes large intestine (see *Physiology: The Vital Processes in Health*, Fig. 2), there is also sometimes an impaction of this refuse matter, and it is in these cases that an enema of larger quantity gives relief.

The simple enema is made of soapsuds. About two pints should be given at a temperature of 100° Fahr. The cleanest appliance for giving an enema is a glass funnel holding about half a pint of fluid, furnished with a rubber pipe to which the nozzle is attached. The ordinary "Davidson bulb" (see *Medicines and Treatment*, Fig. 12) or "fountain syringes" are the most useful in the home. In using the fountain syringe the nozzle is first screwed into place and the bag filled to about three quarters its capacity with the warm soapsuds. This bag should be hung high enough to permit the water to flow with moderate force. The bed should be protected against accident by a rubber covered by a sheet or a sheet folded in four thicknesses and placed directly underneath the patient. When it is possible the patient should lie on the left side with the knees flexed upon the abdomen, so as to relieve all strain. The nozzle should be lubricated with soap and the water allowed to flow freely to expel the air and warm the tube, so that the rectum will not receive a shock by the introduction of air or cold water. The nozzle is then inserted upward, backward, and toward the left at least two or three inches of its length, extreme care being taken not to perforate or injure the walls of the rectum. It will be remembered that the rectum lies to the left of the spine, and the object of placing the patient on the left side is to favour the flow of the fluid downward instead of upward. When the fluid causes pain the enema should be stopped for a few seconds until the pain passes off, and then continued until the patient can bear no more. The nozzle is then gently withdrawn and a folded towel pressed firmly against the anus (the opening to the rectum), thus aiding the longer retention of the fluid and making the result more effectual. In using the "Davidson bulb syringe" great care must be taken that too much force is not used and that the air is expelled from the syringe previous to its introduction. This is done by squeezing the bulb until it is filled with fluid, keeping the suction end always well under water. If the enema be retained another should be given, which will probably be effectual in bringing away the preceding one. If it should be retained altogether no harm is done, as the soap is harmless and the water is readily taken up by the blood.

Administration of Enemata.

An enema of oil is useful in softening hard substances in extreme constipation. This should be given warm (quantity about half a pint) entirely by itself. It is to be retained and followed in half an hour by a soapsuds enema.

A very useful combination for an enema is:

Glycerin	1 oz.
Rochelle salts	1 "
Water	2 "

When turpentine is added to an enema it should first be mixed with oil or the white of an egg, to prevent irritating the rectum.

The larger enema is given in what is known as the "knee-chest position," the patient kneeling, with the chest on the bed. This larger quantity of water acts by distending the intestine, thus increasing its natural wormlike movements, so that the refuse matter impacted higher up in the intestine is propelled downward and expelled.

Nutritive Enemata.

"Nutritive" enemata should be administered every four or six hours. Their long continuance is to be discouraged because of the extreme irritability so often caused in the delicate mucous membrane with which the rectum is lined, and for the additional reason that this membrane, if overtaxed, will cease to absorb, thus shutting off a valuable avenue for the introduction of much-needed nourishment. A rectal douche of cold or tepid water or one containing half a teaspoonful of boric acid to a pint of water should be given once or twice daily, to cleanse and give tone to the rectum. Food introduced in this way should, as far as possible, be predigested, and should never exceed four ounces in bulk. The materials generally used are peptonized milk, beef juice, or extract of beef (Rudisch's Sarcopeptones) and yolks of eggs, with some form of alcohol added when stimulation is required. Many authorities maintain that the white of an egg, being largely albuminous, is to a very limited extent absorbed by the rectum, and is therefore objectionable, as it adds to the bulk and in this way interferes with the usefulness of the enema.

A good size for a nutritive enema is the yolk of one egg, one or two teaspoonfuls of beef extract, eight tablespoonfuls of peptonized milk (four ounces), and half a teaspoonful of salt. This should be warmed to the temperature of 100° Fahr. (blood heat) by putting it in a mug or tumbler placed inside a large vessel filled with boiling water. The greatest care is necessary in cleaning the inside of the syringe after a nutritive enema has been given. If any portion of the material remains it is apt to decompose, stop up the syringe, and make it foul. The nozzle *must* always be boiled before using. *Disease has been conveyed from one person to another because of neglect in this matter.*

Suppositories.

"Suppositories" are used as a convenient means of introducing medication into the rectum. Those containing drugs are made of cacao butter, which melts at the temperature of the body. Those made entirely of glycerin are used for purgative purposes. In giving a suppository the patient should lie on the side, with the knees well flexed, and the suppository should be inserted about an inch and a half into the rectum. Care should be taken to be sure that the rectum is free, and to ascertain afterward that the suppository has been retained.

The object of the "vaginal douche" is to bathe and cleanse the vagina and to reduce inflammation of the opening to the uterus. This is done by introducing into the vagina several pints of warm or hot water twice or three times daily. The recumbent position should always be taken. Any other position fails to accomplish the desired effect. The douche pan (of which there are several makes) should raise the buttocks three or four inches from the bed, the head should be low, and the hollow of the back well supported by pillows. This position allows the water to flow well back into the vagina, so that all parts are thoroughly bathed and irrigated. The fountain syringe or an agate douche-can holding from two to four quarts can be used. The vaginal nozzle containing a perforation at its end should never be employed, as there is danger by this means of water being forced into the uterus, causing serious trouble. The glass nozzle is by far the best for this purpose, as any impurities can be seen and removed. This should be done immediately after use, and before using again the nozzle should be boiled. The temperature of the water, the amount to be used, and the frequency of the douche will be ordered by the physician, and he will also prescribe any medication or disinfectant necessary to be added. A higher degree of heat can be borne after the vaginal walls have become accustomed to the douche. Thus at first the douche may be ordered at a temperature of 105° to 108° Fahr., and later gradually increased to a temperature of 115° or 120° Fahr.

The "Vaginal Douche."

When a patient is very ill or unconscious the evacuations of the bowels and the passage of urine have to be carefully looked after by others. The bowels ought to be well freed once in every twenty-four hours, if necessary, by the use of an enema, suppository, or cathartic, and the bladder should be emptied every eight or twelve hours. When there is difficulty in passing urine there are a variety of simple means by which this can often be accomplished, and they *must be tried faithfully.* The patient should be placed upon the bedpan and water poured from one vessel to another or allowed to run from a faucet within hearing; or warm water can be squeezed from a sponge directly over the lower part of the abdomen. Hot stupes can be applied, or alternations of heat and cold by fomentation and ice. When all these devices fail, the catheter has to be resorted to.

Care of the Bowels and Bladder.

A catheter is a small tube perforated at the closed end and entirely open and free at the other. Catheters are made of a variety of materials. Those in common use are of glass, silver, or rubber. Previous to using, the catheter should be sterilized. Absorbent cotton, pieces of old linen, a basin or large-mouthed bottle in which to receive the urine, should be provided. The hands of the per-

Catheterization.

son who is to catheterize should be well scrubbed with a clean nail brush and disinfected with the bichloride. Without touching other objects, the left hand should be used to open the labia (entrance to the vagina), and all secretions should be carefully washed away with the bichloride, a fresh piece of cotton being used each time. The urethra in the female is one and a half inches long, and the bladder, when moderately distended, is about five inches in length and three inches across. It is tipped slightly toward the front, so that, in passing the catheter, the inclination is in that direction. The meatus or opening to the tube leading to the bladder is to be found just above the entrance to the vagina. The catheter, held firmly in the right hand, is then gently introduced into the meatus and allowed to pass into the bladder. Force should never be used in introducing the catheter, as its direction may be wrong and a false opening made. An apparent obstruction to the progress of the catheter may be the walls of the bladder. *The catheter should always be introduced by sight.* If, owing to the nervousness of the patient or other causes, several successive attempts to introduce the catheter result in failure, the patient should be left to herself for a few minutes and allowed to rest before resuming operations. When the catheter has reached the bladder it will be known by the urine flowing through it. If a constriction of the muscles upon the catheter takes place, a few seconds should elapse before attempting to move it in either direction. Gentle pressure with the hand over the bladder will often insure complete voiding of the urine. Before the catheter is withdrawn the finger should be placed over its end to prevent the urine flowing out over the surface, and the catheter should be withdrawn upward toward the abdomen. All these precautions are essential, as there is great danger of inflammation occurring within the bladder from impurities carried in by the catheter. Except in case of necessity the use of the catheter by the laity is to be discouraged.

Fig. 16.—A test tube.

When the bladder is overfull it should not be entirely emptied at one time, as in this case also there is danger of causing an inflammation. When in taking the urine it is found that a large quantity has been drawn—say about one pint and a half—the catheter should be withdrawn and the remainder removed several hours afterward.

The normal amount of urine secreted by the kidneys of a healthy adult in twenty-four hours is about fifty ounces, or three pints. Sometimes it is necessary to send a specimen for examination to the doctor, and this should usually be taken from the accumulation of the twenty-four hours. A simple test by heat is sometimes useful, especially in

the care of the pregnant woman before confinement. A small quantity of urine should be placed in a test tube, as seen (Fig. 16), or an old iron spoon, and heated over a flame by passing the tube rapidly through it. If the urine becomes cloudy or white, a specimen should be sent at once to the physician.

CHAPTER IX.

APPLICATION OF HEAT AND COLD BY POULTICES, STUPES, PACKS, ICE COIL, ETC.

Effect of Heat and Cold.

The immediate effect of extreme heat or cold upon the capillaries of the skin is almost identical, the different degrees varying only in effect, counter-irritation, the relief of pain, elimination of heat, or control of hæmorrhage being the occasion for their employment. As this article is to deal only with the methods of application, it may be well to give the general caution that heat employed in excess destroys the tissues by burning, and extremes of cold by freezing them. The greatest possible care is necessary when heat is employed that it be not brought too near the skin, as nothing is more distressing than, for instance, a burn on the heel from an unprotected hot-water bottle, or an abdomen blistered by an overapplication of turpentine. This danger of burning is greatly increased when the circulation of the blood is poor.

Poultices.

The uses of poultices and materials from which they are made are to be learned from the article in this volume on *Medicines and Treatment.* Of these materials, flaxseed (linseed) meal probably possesses the most useful combination of ingredients and the power of retaining heat the longest. The proportions are equal parts of water and meal. The water should be boiled, if possible, in the dish in which the poultice is to be made. When boiling it should be removed from the fire and the meal stirred in rapidly till the poultice is of the consistence of a soft solid, and drops without clinging to the spoon. The poultice should then be well beaten from three to five minutes, to make it light by incorporating the air, and spread upon a piece of old muslin of suitable size and shape. The edges of the muslin are turned over the poultice material and the face covered by a piece of cheese cloth or old mosquito netting. The cheese cloth should be made a little larger than the muslin upon which the poultice is spread, so that it can be folded back over the muslin to keep the contents of the poultice in place. If the poultice is to be applied to the throat, the neck, or a

finger, it is well to fold it into one piece of cheese cloth or muslin. This can be done more quickly, it adapts itself more readily to the part, and there is less danger of the poultice squeezing out. Few poultices should be made over half an inch in thickness. Those used for the chest must be of light weight, otherwise they add to the already overburdened efforts of respiration, and those intended for use over the abdominal wall should never exceed a quarter of an inch in thickness. A hot newspaper, plate, or tray can be used to carry the poultice to the sick-room, and oiled muslin, a folded towel, or the hot newspaper can be placed over the poultice to keep in the heat and moisture. Poultices should be retained in place by bandages, or a binder made by doubling a piece of muslin and pinning it firmly about the part of the body to which the poultice is applied. Safety pins should be used for this purpose. The poultice tin should be washed immediately, before the meal dries. This can be done very quickly with a little warm water, and saves much future trouble.

Poultice material should never be used a second time, as it gets soggy and loses its value. Flaxseed meal is inexpensive and can be obtained at any pharmacy. Indian meal and a variety of vegetables are used as substitutes for flaxseed. Stale bread can be soaked in hot water, the water drained off, and the bread used in the same way. Milk should never be employed, as it soon becomes sour and objectionable. Starch poultice is made by first mixing the starch with cold water and then adding boiling water till it thickens. This poultice is sometimes used in abdominal cases where very light weight is desirable, the starch being spread very thinly over the cloth. Slippery-elm poultices should be made of one third slippery elm to two thirds flaxseed meal; a little more water is necessary than that used for plain flaxseed poultice, otherwise it is made exactly the same.

The cotton jacket, or "dry poultice," is made by stitching a layer of absorbent cotton between two pieces of mosquito netting or cheese cloth. This poultice is used for the chest, and is preferable to flaxseed on account of its lightness. It should be cut so as to pin at one shoulder and down one side under the arm. It has to be changed every second or third day, otherwise it becomes foul-smelling from the excretions from the body.

Mustard Plaster.

Mustard plaster should be made in the same way as flaxseed poultice, except that tepid should be substituted for boiling water, as the latter destroys the efficacy of the mustard. This plaster can be spread upon paper if desired instead of muslin. The strength of these plasters varies from the pure mustard, when rapid counter-irritation is desired, to equal parts of mustard and flour, or one to ten or twenty for use upon children. The condition of the skin should be watched constantly when mustard is applied, as its liability to blister is great; its action may continue and destroy the structure beneath the skin.

Hot Stupes.

Hot stupes are best made of two thicknesses of old flannel, preferably of blanket, although new cheese cloth or muslin may be used. The flannel should be folded into a towel and placed in a basin while boiling water is poured over it. The dry ends of the towel are then used to wring out the stupe, by this means making it very hot. A variety of special stupe wringers are made (example Fig. 17), but the simplest methods are often the best. Care must be taken to wring the stupe very dry, otherwise it dampens the clothing and bed, causing great discomfort to the patient. The flannel should be shaken out hastily just as it is applied, to incorporate the air, and thus aid in the greater retention of heat, and oil muslin or rubber should be used as a cover to keep in the heat and moisture. Hot stupes should be reapplied every ten minutes if a high degree of heat is desirable. The counterirritant effect can be increased by the use of turpentine. The turpentine is mixed with olive oil, equal parts (a teaspoonful of each is commonly used), rubbed lightly over the surface, and covered by the hot flannel. This precaution should always be taken, as there is great danger of blistering when turpentine is sprinkled over the surface of the stupe. Severe pain in the stomach or abdomen can be quickly relieved by a hot alcohol stupe, made by saturating a piece of thick flannel in alcohol and placing it between two plates in an oven till hot. It should be carried to the bedside before removing the covering and applied as hot as the skin will bear.

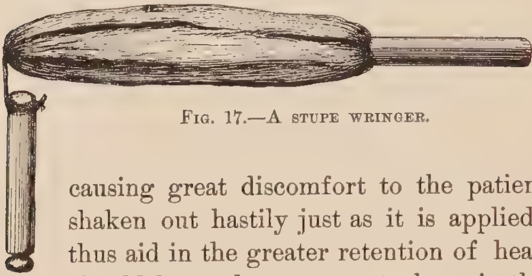


FIG. 17.—A STUPE WRINGER.

Application of Dry Heat.

Heat can also be applied by means of rubber bags or bottles filled with hot water, or bags filled with salt or sand and heated in an oven. The old-fashioned soapstone or bricks heated are also most useful. When the hot-water bag is used it should be filled half full of boiling water and covered with thick flannel. This bag can be applied to any part of the body, and gives great relief from pain. An electric pad has recently been invented for the same purpose. It is rapidly warmed by attaching the cord to an electric-light fixture, and can be adapted readily to any surface. The advantage of this method of applying heat is found in the lightness of the pad and in the freedom from danger of burning the surface over which it is used.

In giving the hot pack the mattress should be covered by a rubber sheet and a large dry blanket. The patient is then enveloped completely in another blanket wrung from water as hot as the hands can bear. This blanket is passed quickly under the patient, one side folded over

the chest and one leg, while the other is wrapped closely around the arms and the other leg and tucked firmly in at the shoulders. This arrangement of the blanket prevents two surfaces coming in contact at any point, and keeps all parts of the body equally moist. The second blanket is then folded over the patient and the whole surrounded by hot-water bottles or hot bricks and covered

The Hot Pack.

FIG. 18.—WET PACK: FIRST STAGE.

FIG. 19.—WET PACK: SECOND STAGE.

by a rubber sheet or blanket to keep in the heat. An ice cap or cold wet towel should be applied to the head. This pack is usually employed when it becomes necessary to withdraw rapidly from the body a certain amount

of fluid, as in severe kidney disease, etc. Its duration should not exceed one hour.

FIG. 20.—WET PACK: THIRD STAGE.

The Cold Wet Pack.

The cold wet pack is given in almost the same way as the hot pack. A long sheet is used instead of the blanket. This sheet is wrung from water varying from 60° to 80° Fahr. The body is enveloped in the sheet and covered in tightly by the dry blanket. Other blankets can be added to exclude the air, and a towel wet in ice water applied to the head. This pack is usually continued from fifteen minutes to an hour. It is commonly used to control nervousness and for elimination of heat from the body.

The Ice Pack.

When the ice pack is given, two sheets are used in place of one, with chopped ice put between them. A large quantity of ice is necessary to produce any appreciable effect in cooling the body, and it has to be constantly replenished. This pack is seldom kept up over twenty minutes.

The Ice Coil.

Cold can be applied to a limited area by means of ice coils made to fit certain parts of the body, as the head, spine, knee, or abdomen (Fig. 21). The arrangement of the coil is as follows: A pail or foot tub containing water, and a large piece of ice wrapped in cheese cloth to prevent the dirt from stopping up the ice coil, is elevated about two feet above the level of the bed, as shown in Fig. 22. The water is siphoned through the coil by means of the Davidson syringe or by excluding the air en-

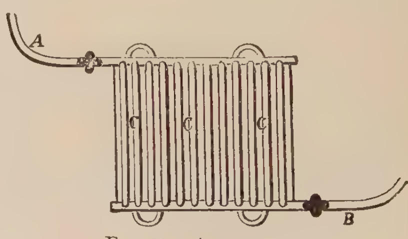


FIG. 21.—AN ICE COIL.
A, tube conducting ice water to, and B, tube conducting it from, the coil.

tirely from the tube by extending it. The tube through which the coil empties should be fastened to a pail at the opposite side of the bed as seen in Fig. 22. Whenever the pail is nearly filled the water can be emptied into the tub and used again.

Fig. 22.—An ice coil in operation.

Cold is also applied by rubber bags filled with chopped ice and adapted to certain surfaces, or by ice poultices. An ice poultice is made by mixing the chopped ice with dry flaxseed and filling it into a bag of oiled muslin made for the purpose. The edges of the bag are held together by binding with adhesive plaster, or they can be turned over and hemmed down. A lapel is left at the top to be fast-

The Ice Poultice.

ened down in the same way after the ice is put in. These poultices can be made of any size. They are particularly useful for the relief of sore throat, or when it becomes necessary to apply cold to the chest or abdomen.

Iced Cloths.

Iced cloths to the forehead give great relief from extreme pain in the head. It is best to have a square of ice provided on which one cloth is cooling while the other is in use. This plan is also valuable when ice compresses have to be applied to the eyes. An evaporating lotion can be made of alcohol, ice, and water. In applying, two thicknesses of cloth only should be used. They should be changed before dry.

CHAPTER X.

MEDICAL NURSING.—CARE OF THE SICK AT NIGHT.

It is difficult to give any correct idea of the care of medical cases without going into a lengthy description of the nursing in special diseases. It may be said, however, in general, that the constitutional symptoms in connection with any disease have to be carefully noted and reported upon, the condition of the alimentary canal, or digestive tract, the skin, the respiratory organs, and the excreta thrown off by them. When the stomach is irritable it is shown by extreme thirst, nausea, or vomiting, and the object of all treatment and care is to overcome this condition and make the retention of food possible.

Care of the Mouth.

Care of the mouth is of the first importance. The sense of taste may be deadened, the teeth injured, the different glands connecting with the mouth and even the ear may become infected by impurities carried in through the tubes. Swabs made by twisting absorbent cotton about a toothpick or small stick, or a piece of cloth wound about the finger, can be used for washing out the mouth, and every particle of impurity must be removed from the roof of the mouth, the teeth, and the tongue. Listerine, much used as a mouth wash, is very cleansing, but a solution of glycerin, lemon juice, and ice is much more agreeable.

Thirst, Nausea, and Vomiting.

Thirst and nausea probably can be best overcome by giving sips of very hot water at frequent intervals, or "ice pills"—cracked ice subjected to hot water to remove the sharp edges—can be given. The patient should be instructed to swallow the pills whole, as melted ice becomes warm before it reaches the stomach, and does more harm than good. If cold water is

allowed, a small glass one third full will usually satisfy the patient as fully as a large one filled to the brim, and will do less harm. Vomiting is often controlled by the use of capsicum or mustard plaster over the pit of the stomach, or by giving nourishment or acidulated drinks in very small quantities, with ample rest between. The modern remedy (but one to be used only in experienced hands) is the stomach tube. The apparatus consists of a flexible rubber tube about sixteen inches in length with an opening on either side near one end, and a glass funnel and rubber tube, connected by means of a glass pipe, to the other. (See *Medicines and Treatment*, Fig. 10). This apparatus is used both for washing out the stomach and for feeding. It is important that the tube be kept perfectly clean, especially when used for feeding. All vomited matter should be examined, and in serious cases saved, as it is often of great diagnostic value to the physician.

Fæces and Urine.

The nature, frequency, appearance, and odour of the movements from the bowels are all important, and such points as the following should be reported: The presence of mucus or fresh blood in diarrhœa or other movements; small round, hard pieces, or those flattened into ribbon shape in constipation; the colour, if it be natural or absent, as in "clay-coloured" dejection when jaundice is present, or yellow and of the consistence of "pea soup," as in some cases of typhoid fever, or black from the presence of some drug, as iron; or it may be black and tarry from blood that has remained for some time in the intestine; the frequency, amount, and condition of the urine—if there be difficulty in passing it, or if it be retained altogether. If the appearance of blood is present in the urine, make sure that it is not due to the monthly period.

The Skin.

The skin, if acting well, should be moist and soft. When it becomes dry, hot, or glazed, or unusually hard, the proper amount of perspiration can not pass off, and other organs of the body are taxed accordingly. It should also be carefully examined for any eruption that may be present.

Respiratory Organs.

When the respiratory organs are affected the respiration must be carefully counted, the frequency and severity of cough noted, and the expectoration carefully examined.

Purulent or bad-smelling sputum should always be disinfected, but it is especially to the expectoration in cases of consumption—phthisis, tuberculosis of the lung—that our greatest attention should be directed. If the sputum containing these poisonous germs be allowed to dry and fly about in the atmosphere the greatest possible harm may be done. Such germs will be sure to find lodgment in lung tissue too weak to resist their action, and the disease, once fastened upon a human being, is hard to eradicate. *Prevention is then our line of action, for it is now believed*

that if these germs were destroyed immediately upon being coughed up the disease would disappear entirely. Heredity in this case means only the inheritance of a weak and susceptible lung tissue, and not disease transmitted by the blood. When this disease is known to be present, those who realize its infectious nature will surely be conscientious enough to avoid expectorating upon floors, sidewalks, or even on the ground, or in any way distributing the seeds of a disease so fatal.

The "sanitary sputa cup" (Fig. 23), made from paper prepared especially for the purpose and impervious to fluids, should be used. The paper can be procured cut and folded as seen in Fig. 24, and simply tied about with a bit of string, or the cup with an adjustable frame can be purchased in quantities. The special advantage of this cup over one made of china is that it can be burned without risk to a second person, who may be obliged to empty the contents of the china cup. The cup when in use should always be filled one third with a disinfectant—bichloride (1 to 1,000), or carbolic (1 to 20). This is done to imprison and kill the germ as soon as it appears. While the germ is moist there is positively no danger of conveying the disease to others. For this reason handkerchiefs, upon which the sputum is likely to dry, should never be used. Use instead small pieces of soft muslin or cheese cloth or Japan paper, and burn them at once. If this is not possible, a hinge can be made in the top of a box cover and the napkins kept closed in the box till they are burned. The china cup or the frame used for the sanitary cup should be boiled once in twenty-four hours.

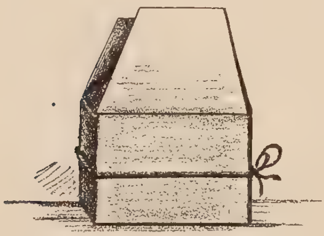


FIG. 23.—SANITARY SPUTA CUP.

Excreta.

The disinfection and disposal of excreta belong particularly to the person caring for the sick, and it is here that almost her greatest usefulness can be exercised. In typhoid fever, for example, the poisonous germs are found entirely in the evacuations from the bowels, and it is necessary to make sure of their destruction, otherwise they readily find their way into the water supply and thus contaminate food and drink. To become active, this special germ must be swallowed. The discharges containing the poison must therefore be thoroughly broken up and well mixed with a solution of bichloride of mercury (corrosive sublimate), one part to five hundred of water, or carbolic acid (1 to 20). This must always be done before throwing them into the sewer, and in country places, where sewage does not exist, a trench as distant as possible from the water supply should be dug two or three feet deep, and each evacuation, after thorough disinfection, should be thrown into the trench and covered with chloride of lime and fresh

earth. All clothing removed from the bed should be immersed in carbolic solution, and the hands, whenever they have come in contact with the typhoid patient, should be disinfected.

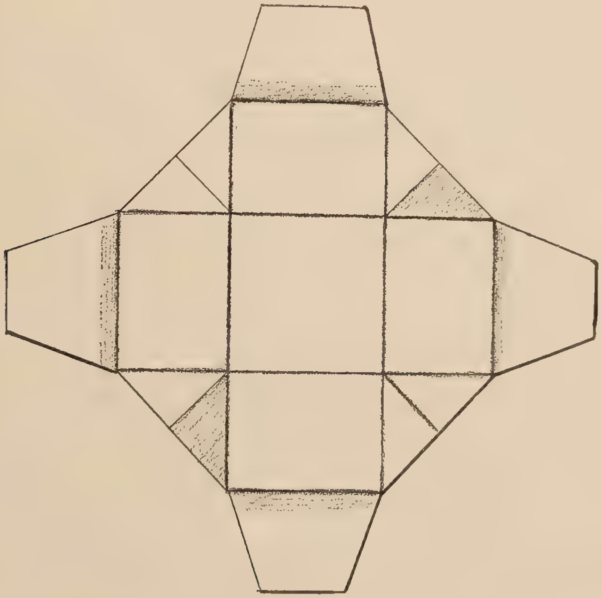


Fig. 24.—Diagram of sanitary sputa cup.

Position of the Body.

In certain diseases the position of the body is of such importance that a word just here may not be out of place. In peritonitis, pneumonia, and typhoid fever the strictly recumbent position must be kept, and the use of the bedpan and urinal enforced. In pneumonia every advantage for the expansion of the diseased lung must be given, and as little work put upon the heart as possible. In typhoid fever and peritonitis the friction of movement or pressure brought upon the abdomen would tend to increase the inflammatory process and lessen the chance of recovery. The upright position has to be maintained in cases where there is difficulty of breathing, either from heart disease, fluid in the chest or abdomen, or from asthma.

Preparations for the Night.

In caring for the sick at night, preparations should be made so that the patient may not be disturbed unnecessarily. Squeaking doors should be oiled and all utensils handled with the utmost care. The dress and shoes worn by the night nurse must be free from rustle and noise, her movements quiet, and her manner soothing. A small tin refrigerator placed just outside the sick-room is useful in saving steps, or one may be improvised by the employment of a foot tub, large pan, or bowl. The ice should be raised

from below by pieces of wood, and the rapid melting of the ice prevented by enveloping it in flannel or newspaper. The "old doctor's icepick" (a stout pin with a weighted knob), or a hat pin can be used for the cracking of small pieces of ice noiselessly, or it can be chopped in a bag, and kept in the room suspended in cheese cloth tied over a bowl. The coal should be prepared as previously described, and brought noiselessly, and an extra blanket or two provided. The eyes of the patient should be protected from the light, and from shadows cast upon the walls and ceiling, as these are often more disturbing than the light itself. A "fairy light," gas, or electric globes, covered by dark cambric shades, or a candlestick with reflector, can be used. The shadows can be prevented by standing the light within a canopy made by bending pasteboard into sections, or standing three books on end and covering them by a fourth. The clock has often to be removed, as the constant ticking disturbs many people and prevents sleep.

Quieting the Patient.

Nervousness, sleeplessness, restlessness, and general discomfort of the body can often be overcome by giving a cool light sponge (if allowed) either with water or alcohol, or freshening up the bed and cooling the back of the patient by fanning either with the bedclothes or a fan. The application of heat or friction, usually called "rubbing," will often relieve pain and put the patient to sleep. Simple methods of relief should always be tried before drugs are resorted to. The question whether sleep or nourishment is of greater importance is a difficult one to settle, and when the illness is of a critical nature, definite orders from the physician should be obtained. Stupor is often confounded with sleep, and patients in this condition have been allowed to pass away without the proper remedies or nourishment being given which might have saved life had the true condition been recognised. The ebb of human life is said to be lowest between the hours of 1 and 5 A. M., and it is during these hours that the greatest watchfulness is necessary. The extra blanket, the nourishment or stimulation, should be given at this time.

Ventilation at Night.

The ventilation of the room at night frequently becomes a serious question, as many people are opposed to inhaling what they consider the "dangerous night air." They are much more willing to breathe over again the air contaminated by the poisonous exhalations from their own lungs. It is time that this popular prejudice were overcome. The admission of too large quantities of the air, deprived in part of its oxygen by the absence of the sun, would be objectionable, but the constant admission of a small quantity is essential and not hurtful.

CHAPTER XI.

SURGICAL NURSING.

The general principles that apply to the nursing of medical cases may be followed in surgical nursing, and it is only in the technique of the dressing of surgical wounds and in the preparation of those about to undergo a surgical operation that there is any essential difference.

The subject of injuries, wounds, and the emergencies and diseases entailed by them, has been so ably dealt with in the article in this volume entitled *Surgical Injuries and Surgical Diseases*, that further mention of the subject is intended only to impress upon the reader the necessity of carrying out these general rules.

Surgical Cleanliness.

Surgical cleanliness, or asepsis, may be simply described by saying that the hands, the instruments, the towels, the utensils—in fact, anything surrounding the wound that is likely to be touched or to come in contact with its surface must, as far as possible, be made free from germs. Sterilization by steaming, boiling, or subjecting to a strong disinfecting solution is therefore necessary. In dressing a clean wound, even though slight, the same care in detail is necessary as in one of a more serious nature, as the danger of introducing poisonous material is just as great. Whatever is to be used for dressing, whether it be muslin or cheese cloth (unless the antiseptic corrosive-sublimate gauze obtainable at any drug store be used), the towels, and the water to be used upon the surface of the wound, should be boiled, and small wads of absorbent cotton or cheese cloth—prepared also by boiling—for the sponging. The basins or bowls for solutions, and those in which to remove the old dressings, should be perfectly clean. The bed and parts immediately surrounding the wound should be covered by towels and protected underneath by a rubber or large pieces of thick wrapping paper. The assistant's sleeves should be put above the elbows and the hands well scrubbed with a clean nailbrush—especially about the nails—in a lather of hot water and soap, for from five to eight minutes. They are then washed for five minutes in a solution of bichloride of mercury (1 to 1,000).

Dressings.

The greatest possible care and delicacy should be used in removing old dressings. Those adherent to the wound should be soaked off with antiseptic solution and carefully lifted from either side instead of being ruthlessly torn off. Avoid touching the surface of a wound and thus breaking up the newly formed or forming tissue. Remove discharges from the surrounding skin by washing toward, not from, the wound. All soiled dressings, especially those

containing the fatal poisonous discharges from tubercular joints or syphilitic ulcers, or those saturated by pus, should be burned at once. If such dressings be wrapped in newspaper there is no possible objection to their being burned even in a cooking stove.

PREPARING FOR OPERATION.

The Patient.

In preparing a patient for operation attention should be given to the following points: The stomach, the intestinal tract, the bladder, and the surface to be operated upon. The diet two or three days previous to the operation should be somewhat lessened in quantity, but nourishing, and during the day immediately preceding the operation should consist chiefly of fluids, avoiding milk. The intestinal tract should be made free from any accumulation of fæcal matter by cathartics, and a thorough enema given on the morning of the operation. The part to be operated upon should be well cleaned, disinfected, and shaved, if necessary. The oily matters of the skin, usually filled with poisonous bacteria, can be removed by liquid soap, ether, or alcohol, and a disinfecting dressing applied some hours before the operation. But special instructions in these matters will be given by the surgeon in charge. A bath should be given, the hair divided and braided firmly on either side close to the ears, if the patient be a woman, and when an anæsthetic is to be administered, any false teeth should be removed. A loose night-gown and wrapper should be worn, and long, warm stockings, or those made especially for the purpose from pieces of old blankets, as seen in Fig. 25.

Fig. 25.—Flannel stocking for use during operation.

The Room.

In preparing the room for a surgical operation it should be cleared of all unnecessary articles—*i.e.*, pictures, ornaments, upholstered furniture — in fact, everything upon which dust can lodge. Have the room carefully swept, well aired, and wiped with a damp cloth, and at the time of the operation heated to a temperature of from 75° to 80° Fahr. Lay a drugget or thick wrapping paper about twelve feet square, or ordinary rugs turned wrong side up, near the best lighted windows, and on this place a firm kitchen table, or boards resting on stands, or barrels of the same height—even an ironing board can be used in some cases. This table should be padded with a thick blanket neatly folded and covered by a

sheet. A firm, flat-bottomed chair should be provided for the surgeon, and a stiff cushion or folded blankets furnished in case the chair is not high enough. Have one or two stands upon which to place instruments, dressings, etc.; plenty of hot and cold water, ice, hot-water bags, bottles or bricks, brandy and a Davidson syringe in case a stimulating enema is required; alcohol and ether to clean the skin, and tablets of bichloride

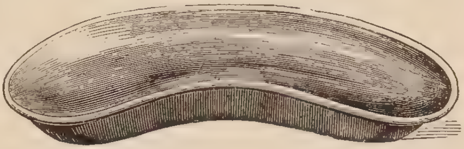


FIG. 26.—A CRESENT-SHAPED BASIN.

of mercury with which to make solution; three china pitchers, and basins for instruments (preferably hand basins), or the instruments can be placed on a stand covered by towels wrung from carbolic-acid solution; a toilet soap dish for ligatures; soap and nailbrush; two pails or slop jars all scrupulously clean; eighteen towels (old without fringe preferred); rubber sheeting; boiled water for instruments and sponges. An ether cone can be made by covering a folded newspaper with a towel and twisting it into a cornucopia. A small blanket should also be provided with which to cover the patient on the operating table. Things not obtainable in the house—*i. e.*, gas or oil stoves, basins, table, etc.—can usually be hired temporarily. At the time of operation a second person should be in attendance for any emergency that may arise. The surgeon generally furnishes the sponges, dressings, instruments, and anæsthetics.

The Bed.

The bed to be occupied after operation should be protected by a rubber, and made up firmly with an extra folded sheet to be placed directly under the part operated upon, so that it can be easily removed in case it becomes soiled by discharges or hæmorrhage. The bed and blanket in which to envelop the patient on his return should be thoroughly heated by the use of hot-water bags or bottles.

After the Operation.

A crescent-shaped basin (Fig. 26) or toilet soap dish and towels should be provided, as there is usually vomiting after the administration of ether. This vomiting from ether is sometimes hard to control. "Ice pills," or hot water given in small quantities, or a tumblerful of tepid water—used to wash out the stomach by increasing the vomiting temporarily—prove useful means of getting rid of the ether. The disagreeable taste of the ether can be somewhat removed by washing out the mouth and rubbing the tongue thoroughly with ice water. An ether chill is frequently seen in people with nervous temperament. It means nothing and should cause no alarm. The patient should never be left alone while coming out of ether, as choking is liable to occur either from the materials vomited or from swallowing the tongue. This is a

serious matter, as it is a question of minutes only when the oxygen is entirely shut off from the lungs. In almost any of the other emergencies immediately following operation—hæmorrhage, heart failure, etc.—the foot of the bed can be elevated from the floor by placing a strong chair underneath the footboard; external heat can be applied, and a small amount of brandy or whiskey given in hot water by enema.

CHAPTER XII.

OBSTETRICAL NURSING.

No inexperienced person would attempt to perform a surgical operation of any magnitude, and no person ignorant of the mechanism of childbirth should wish to carry a woman through such a critical experience, except in an extreme emergency. A physician should be consulted in the early stages of pregnancy and should have the entire direction of the woman during this period. Arrangements to secure a nurse thoroughly trained in obstetrical practice should be made early, as those who follow this branch of nursing successfully are often engaged six or seven months in advance. The nurse will be able to give information about the articles required and arrangements to be made for the confinement, and should, if possible, be shown the topography of the house in which the confinement is to take place.

Pregnancy.

If medical supervision is impossible, attention should be given to the following points: Daily exercise for an hour or two in the open air, good hygienic surroundings, and at least eight hours' sleep during the twenty-four are essential; clothing loose enough to allow of free circulation of blood; frequent bathing, the sitz bath being employed when the full bath proves too exhausting; a generous but not too stimulating diet, and rigid regularity in eating should be adhered to. The bowels, if not regulated by food and exercise, should be moved daily either by purgative enema or simple laxative. The urine should, if possible, be examined at intervals during pregnancy, and at least four times during the last two months; this is of serious import to the patient, and must not be neglected. The nipples require preparation or toughening. A daily application of solution of borax—a tablespoon to one pint of water—can be used, and fresh cacao butter or albolene used for lubrication.

Labour.

The date at which labour is likely to occur can be calculated in a variety of ways, one of the simplest being to add seven days to the date of the beginning of the last menstrual period and count

forward nine months. This is usually within a week of the correct time, although a difference of three weeks sometimes occurs.

A large, well-ventilated room free from sewer connections, having, if possible, a southern exposure, should be chosen. This room and its contents should be thoroughly cleansed from dust and other impurities, and if obliged to retain old stuffed furniture and draperies, cover them, if possible, with clean sheets. Ascertain, if possible, that no contagious disease germs have been recently present there.

Have in readiness two rubber sheets long enough to tuck under the mattress, or the same amount of tar paper; a large thick "sanitary pad" used to protect the bed; twelve clean sheets and twelve old soft towels recently laundered; several small squares of cheese cloth, to be used for sponging; a large rug that will extend well under the bed can be inverted and made to protect the carpet; binders and safety pins of different sizes; sanitary napkins; an earthenware bedpan; Davidson's bulb or a fountain syringe; three pitchers for water; bowls, or preferably hand basins, for solutions, and one in which to receive the placenta; two new nailbrushes; a slop jar and pail; plenty of hot and cold water; carbolic acid (1 to 20) and bichloride solution (1 to 1,000); brandy, whiskey, and a glass and water for administration by mouth; glycerin for the hands; a yard of linen bobbin, a sixteenth of an inch wide, for tying the cord; albolene or sweet oil with which to remove the waxy secretions from the child's body; a soft blanket in which to wrap the child; a child's bath-tub and thermometer; unscented soap—white Castile, the purest form obtainable, preferred; small pieces of linen or gauze to wash out the eyes; and a set of baby clothes.

The square "agate seamless bed or douche pan" and the "agate douche or irrigator," holding from three and a half to five quarts, will answer all purposes and completely take the place of syringes and the ordinary "slipper" or "Eureka" bedpan. This entire outfit can be purchased at any drug store, or the "pan" and "irrigator" can be obtained at less cost at a crockery store where agate ware is kept, and the rubber tubing, "stop-cork," and nozzles at a drug store. While the original cost of these is probably a little higher (about five dollars), they obviate the necessity of having two sets of utensils, and are more durable.

Dressings.

The materials used for the obstetrical dressings can also be purchased at any drug store, or where surgical supplies are kept. Absorbent cotton or cotton waste, absorbent gauze, oiled paper, bichloride tablets (seven grains and a half to the pint of water make a solution of 1 to 1,000), and carbolic-acid solution (1 to 20) are necessary. Pound packages of the cotton and packages containing five yards of the gauze are most economical. The best substitute for the gauze is a good quality of bleached cheese cloth.

The sanitary pad should be about three feet square. In making it, take a piece of oiled paper of this size and cover with a thick layer of cotton waste, place it between cheese cloth and tack the whole loosely about the edges with long stitches. The sanitary napkins are similarly made. They should be of two sizes, those to be used immediately after delivery being much wider and longer than those used subsequently. The cheese cloth can be cut about twenty-five inches square and filled one third its width and a little less than its length with cotton waste. The gauze is then folded over and stitched down the centre and across the ends (Fig. 27). The smaller napkin is made in the same way, except

FIG. 27.—SANITARY NAPKIN.

that it should be much narrower and the cotton waste should extend only about ten inches of its length, thus leaving the ends free and firm for pinning. These napkins are sold at about fifty cents per dozen, but they can be made at much less expense. Both the pads and napkins can be sterilized by placing them in a covered dish or between two pans in an oven and subjecting them to a slow heat for about four or five hours. Avoid exposing them to the air till ready for use.

The bed should be made by covering the mattress first by a clean sheet and then by a rubber sheet or tar paper (inexpensive and to be burned after use) put lengthwise across the centre of the bed and tucked firmly in at the sides. Over this spread a second rubber or tar paper and cover with another sheet. Then put in place the "sanitary pad," or, in the absence of this, three sheets folded in four thicknesses to absorb the discharge.

True and False Pains.

The signs of beginning labour are pains in the lower part of the abdomen and back, occurring at regular intervals about once every half hour, and a discharge of mucus tinged with blood from the vagina. True pains can be distinguished from those that are false by placing the hand over the lower part of the abdomen; in true pains the contractions of the uterus are to be readily felt through the abdominal wall. As the labour advances the pains grow more severe and the intervals shorter. The first stage of labour consists in the dilatation of the uterus and ends when

the membranes have ruptured and the uterus is completely dilated. The second stage, or stage of expulsion, ends when the child is born. The third stage ends when the placenta is expressed and the uterus contracted to the size of a closed hand.

The Person in Charge.

The person in charge of the patient should make an entire change of her personal clothing, and should always wear while on duty washable dresses and aprons, keeping herself scrupulously clean. During the puerperal or childbearing stage a woman is peculiarly susceptible to infection, and it is almost criminal to undertake the care of a woman about to be confined after being in contact with any disease either contagious or "septic" that is communicable.

The diminution of the condition or disease known as "childbed fever" or "sepsis" is due, no doubt, to the aseptic and antiseptic precautions now being enforced. Let it be the motto of every one undertaking such responsibility to carry out implicitly all the aseptic and antiseptic precautions given.

When the labour pains begin the person in charge should notify the doctor. This is best done by writing a note describing the nature and frequency of the pains and the condition of the patient.

"First Stage" of Labour.

In the "first stage" of labour the patient should be allowed to walk about and occupy herself, or sleep if inclined to do so. The bladder should be frequently emptied and the large intestine made perfectly free of any accumulation of fæcal matter by an enema. This makes the labour easier and sometimes shortens its duration. Simple fluids should be given, avoiding alcoholic or other stimulants. The patient must be instructed not to bear down during the pains of this stage, and to sit, if walking about, when a pain occurs. This rule should be adhered to, as there is danger of too early rupture of the membranes and protracted and painful labour in consequence.

Examination by the Doctor.

Have in readiness for the examination by the doctor hot water, soap, two clean nailbrushes and two bowls, one containing a disinfectant solution for the hands. Before preparing the patient for the examination the hands and forearms of the attendant should be scrubbed for three minutes in hot soapsuds with a stiff nailbrush and washed again for five minutes in a disinfectant solution. The nails should be kept short and care taken not to roughen them. Use for cleaning a bone or a wood cleaner, and prevent the roughening of the skin of the hands by the use of glycerin and by wiping them perfectly dry.

The patient should be dressed in a loose wrapper and placed on the back at the right side of the bed, with the clothes drawn out of the way

and two sheets adjusted, one over each leg, to protect the body during examination. After dipping the hands in the disinfectant clean carefully the external genitals and surrounding parts with soap and water and afterward with sterilized water or disinfectant solution, and remember that the hands should always be held in a disinfectant each time before touching the genitals. Care should also be had not to touch or handle unnecessarily unclean surroundings.

"Second Stage" of Labour.

During the "second stage" the patient must be kept strictly in bed and not allowed to leave it for any purpose. She should be covered by a sheet folded and tied loosely about the waist by a tape passed through the middle and fastened securely to the nightgown, which can be gathered in soft folds well up under the arms. Strong safety pins should be used to pin the sheet, which is lapped over on the right side so as to cover both legs; the feet should be enveloped in a pair of white cotton stockings.

Delivery is usually made with the patient lying upon the left side, but some practitioners prefer the patient placed upon the back. Firm pressure made upon the lower part of the back during the pains gives relief (in doing this the hand of the attendant should be kept "clean" by using a disinfected towel), and the patient may be allowed to pull on a sheet firmly secured to the foot of the bed. This greatly increases the expulsive power of the uterus, and must be avoided in rapid delivery, otherwise the parts may be ruptured.

"Third Stage" of Labour.

In the "third stage" the person assisting may be called upon to hold the uterus by placing the hand upon the abdominal wall and watching to see that it remains properly contracted. Sometimes it becomes necessary to make circular movements over the uterus or to grasp it, and pushing firmly downward promote contractions till the placenta, which should always be kept for the doctor's inspection, is delivered.

In Emergency: Care of the Mother.

In emergency, when no doctor is present, the patient should be placed on the left side with the knees flexed. All antiseptic precautions being taken, the perinæum should be carefully watched. When the head is to be seen, place the fingers against it and hold it back during the pains, to prevent too rapid descent and to allow the gradual stretching of the vaginal walls. If this plan be faithfully carried out there is little danger of laceration. With the first child the labour is often slow, a half hour or more being required for the passage of the head. In subsequent labour the time is usually much shorter, allowing little opportunity for proper preparations. If the head is coming too rapidly, tell the patient to open her mouth and avoid bearing down. When the head is delivered insert the finger into the passage to see if the cord be about the neck, and if so pull it carefully

over the head and wipe the eyes and mouth free from secretion. The hand should then be placed on the abdomen over the uterus, moved downward till the child is expelled, and still held firmly till the placenta is expressed and the uterus contracted. The placenta should be twisted as it is expelled till all the membranes come away. The uterus should be held for at least half an hour after, or until the pulse is below 95. The pulse should be taken frequently, and if it becomes very rapid a physician should be called at once, as this probably indicates hæmorrhage.

Care of the Child.

As soon as the child is delivered the patient can be turned on the back and an assistant told how to watch and hold the uterus, so that attention may be given the child. The child should first be made to cry out by slapping the face with the wet hand or a towel. If it fails to respond to this treatment, and is not breathing, the cord should be cut at once (it is usual to wait till pulsation has ceased). This is done by tying it with bobbin about two inches from the body, and again two inches from that, and cutting between. Frequent subsequent examination of the cord is necessary to be sure no hæmorrhage is taking place. The child's body should then be immersed in a hot bath at a temperature of 100° to 105° Fahr. The head should be bent backward, and a piece of gauze or a handkerchief placed over its mouth so that air can be blown into the lungs by breathing through the covering. This should be done at least twelve or fifteen times, or till the child takes a long breath.

Care of the Mother after Delivery.

When the child is successfully delivered, as described, the patient should be cleansed of discharges by bathing all parts either with warm water that has been boiled or with a disinfectant solution, sterilized gauze or muslin that has been disinfected being used. *Be very careful to resterilize the hands always before touching the genitals.* When all impurities are removed, one of the above-mentioned "sanitary napkins" should be used. If not sterilized, a few layers of gauze saturated in disinfectant solution may be placed over it.

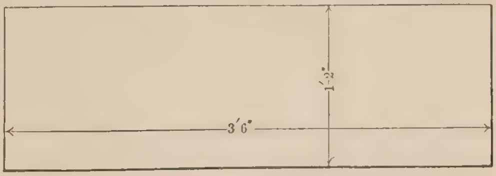


FIG. 28.—ABDOMINAL BINDER.

Abdominal Binder.

The soiled pad and bedding should be removed and replaced by clean. An abdominal binder is then usually applied. This binder should be made of unbleached muslin or bleached twill. It is three feet six inches in length and fourteen inches in width (Fig. 28), and should, when pinned in place, extend from the border of the ribs in front to below the prominence of the hips. It should be made to fit perfectly the contour of the body by

taking in darts both above and below. To this is fastened the "sanitary napkin" held in place by four large safety pins.

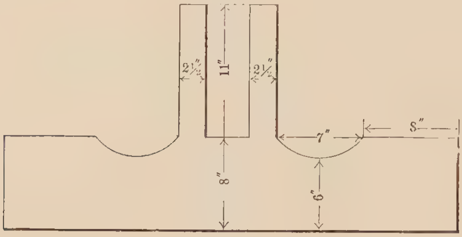


FIG. 29.—BINDER WITH SHOULDER STRAPS.

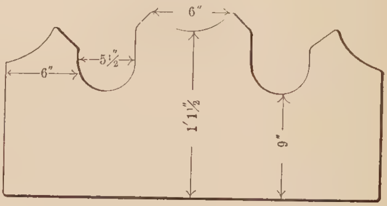


FIG. 30.—SLOANE BREAST BINDER.

Breast Binders.

Compression is made upon the breasts either by the use of the binder with shoulder straps (Fig. 29), the "Sloane binder," or the "Y breast bandage." The Sloane breast binder (for dimensions and shape of which see Fig. 30) is first pinned firmly together down the front with medium-sized safety pins. Next, the darts are taken in and the bandage attached to the abdominal binder by pinning it about the waist, the whole being completed by fastening it firmly at the shoulders (Fig. 31).

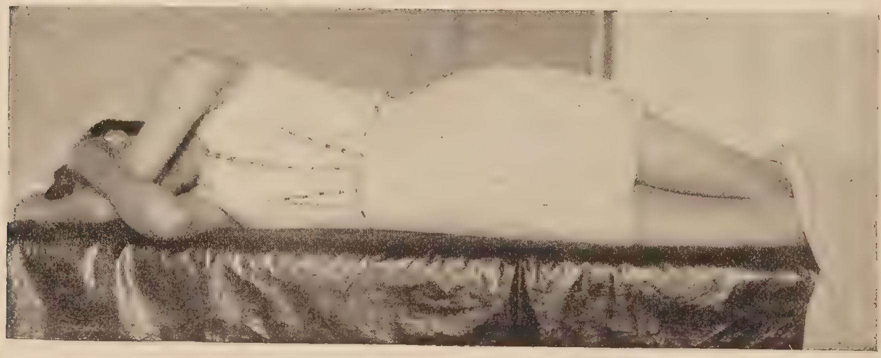


FIG. 31.—THE SLOANE AND ABDOMINAL BINDERS APPLIED.

The Y breast binder, originally used in the Boston Lying-in Hospital, has the advantage of leaving the nipples exposed (Fig. 32), thus saving unpinning at each nursing period. The nice adjustment of this bandage requires considerable practice. A T bandage is made by folding a towel lengthwise and pinning it at right angles to another towel folded in the same way. The T is then made into a Y by making a diagonal fold in the middle of the cross piece and fastening the corners of the plait with safety pins. In putting the bandages on the long end of the Y is passed under the back and pinned to the other ends as they are brought across, one above and the other below the breasts. Smooth, thin layers of ab-

sorbent cotton should be placed between the bandage and the breasts, at the sides, and also under and between the breasts, to make the compression even and prevent chafing. Where the breasts are small it is sometimes an advantage to pin the bandage together in the centre.

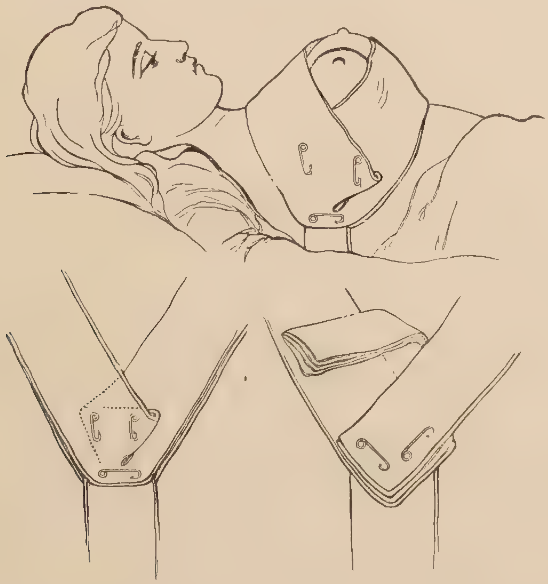


FIG. 32.—The upper figure shows the double Y breast bandage in position. The lower left-hand figure shows how the Y bandage is made. The third figure shows how the double Y bandage is completed by fastening the arms of the Y to the tailpiece on the patient's opposite side.

Both the abdominal and breast binder should be changed as often as soiled. They are usually worn about seven days, although their use may be continued longer if comfort is derived from them.

General Rules.

The general rules for the care of medical cases apply to obstetrical nursing as well. During the first week or more visitors should be excluded, as rest and quiet are of so much importance. The patient should be kept on her back for the first six or seven hours, and must not be allowed to sit erect during that time; afterward the position may be frequently changed. In some cases the freedom of the room is allowed within ten days, and many women who are strong resume their usual routine of life at the end of three weeks. Too great haste in this matter is often regretted afterward when some uterine difficulty traceable to carelessness at this time appears.

The bed, the patient, and the room must be kept perfectly clean. Some practitioners allow a bath every second day. The greatest possible care is to be used in giving it that the patient is not chilled. The napkin will have to be changed at first every hour and later every three to five hours, the parts being thoroughly cleansed and kept free from

odour. All soiled clothes must be removed at once; the napkin can be wrapped in paper and burned immediately.

The diet is usually liquid for the first twenty-four hours, and if all symptoms are normal after that a full meat diet is often allowed.

The bowels are usually moved on the third day by an enema or glycerin suppository or other medication by mouth. *Medicine or vaginal douches should be given only when ordered by the physician.*

If there be retention of urine try the simple methods mentioned in Chapter VIII of this article; without orders use the catheter only in emergency, and not more frequently than every eight hours.

The breasts also require careful management. The nipples should be cleansed after every nursing with some weak antiseptic—*i. e.*, boric acid or other solution—to prevent cracking and infection. If the breasts become too full give fluid sparingly, and apply a bandage for compression, or rub very carefully with the hands from the base toward the centre of the breast, the motion being circular. Rubbing is not advised where inflammation is present. The amount and colour of the discharge—lochia—is important. Normally it should be more or less bloody for the first four days, growing gradually thinner and losing its colour till it ceases, sometimes within two and sometimes not for four weeks. It should never have a bad odour. Report carefully all other symptoms—pulse, respiration, temperature, chills, pains, condition of the tongue, stomach, etc.

CHAPTER XIII.

CARE OF THE NEWBORN CHILD.

The First Bath.

The child should be carried into a warm room, 75° Fahr. The face should be cleansed and the eyes wiped with a bit of soft linen, care being taken to remove the secretions from the lids before applying any solution that may carry *in* the impurities. Wash the mouth with lukewarm water, using the little finger gently so as not to irritate the delicate membrane. If the child be strong, the bathing may be done an hour later, on the lap, in a blanket, to avoid chilling.

The Full Tub Bath.

After this the full tub bath can be given daily with safety (temperature of the water 100° Fahr.). The child is lifted into the tub by grasping the ankles with one hand, supporting the head and shoulders with the other, and held while bathing by the thumb and little finger placed in the armpits, allowing the head to rest upon the other fingers spread out like a fan at the back. Keep the body

well under the water for about five minutes. Use a fresh cloth rather than a sponge, and avoid too great friction of the skin or scalp.

General Rules.

Never use a fine-tooth comb on the scalp; a soft brush is better. Avoid powder, or use sparingly. Compound talcum or lycopodium are probably the least irritating. The navel cord should be well powdered and enveloped in dry absorbent cotton, unless otherwise ordered, and held in place by the binder sewed on snugly. Avoid making the binder too tight for comfort, or in any way limiting the movements of the chest.

Frail children should be bathed with caution, and some amount of medication may be introduced through the skin by the use of sweet oil applied daily, instead of the bath. They should have extra heat supplied to the body by means of hot-water bottles, and the greatest possible care exercised to prevent chilling, which might prove fatal.

Infant's Clothing.

The "Gertrude" suit presents the most useful and hygienic mode of clothing an infant. The band gives firm support to the abdominal wall; the slip and skirts, supported at the shoulders, are of uniform thickness throughout, thus avoiding the faults of the old-fashioned method of dressing, with its multiplicity of pins, bands, and uneven distribution of heat and weight. The clothing should be warm, of light texture, and so loosely applied that free movement of the trunk and all extremities is possible. The child is dependent for enjoyment and exercise upon two things—namely, full respirations (crying?) and kicking.

The napkins should be of "cotton diaper" of two sizes, the large ones to be folded in a triangle, the smaller in a square, one point of which extends well up under the band to prevent its being soiled.

When soiled or wet, the napkin should be changed at once and placed in a bucket of water in the bath-room till taken to the laundry. Napkins that have been wet should not be dried in the nursery or reapplied till laundered and thoroughly aired, as they add to the impurities of the air, and cause chafing.

Inflamed buttocks can be treated by washing thoroughly with soap and water whenever the napkin is changed, and dusting with lycopodium powder. If this fails to reduce the inflammation, stearate of zinc may be used.

Fæces.

The passages of a newborn infant are greenish black, and of the consistence of tar, until all the contents of the bowels at birth are evacuated. When the mature milk of the mother is taken, about the fifth day the passages become normally pasty and of a yellowish "canary colour." After the child has become accustomed to the milk diet, if the passages show greenish streaks of mucous and undigested curdy masses the digestion is not perfect.

The eyes should at first be directed away from strong light, but the mouth should always be left uncovered for the entrance of oxygen.

Fresh Air and Exercise.

Fresh air is as necessary for health and growth as proper food and regulation of the bowels; and it is important that the child should have every opportunity for physical development from the first. It is safe to say that the child may be taken out of doors in fine weather at the end of ten days, and on pleasant days in winter when three months old.

Regular habits of eating and sleeping must be established from the first. This is very simple, for the child knows only what it is taught.

Feeding.

During the first three days the child should be put to the breast four or five times, beginning after the mother has had her first sleep. Although there is little milk secreted at this time, it is a known fact that the nursing aids in the contraction of the uterus, satisfies the cravings of the child, and that the colostrum (first milk) helps the bowels to throw off their contents. During this time the child should be fed only plain warm water, as the sweetened water so often given causes flatulence.

The mother's milk comes between the third and fifth day, usually in abundance. The child should be nursed at both breasts every two hours during the day and twice at night, the nursing to be continued fifteen or twenty minutes. This plan is usually carried out for the first month or six weeks, when the interval is lengthened to two and a half hours. No artificial method of feeding will ever take the place of mother's milk, and this fact should be urged upon mothers who wish to escape this taxing ordeal.

It is sometimes a difficult matter to make the child take hold of a small contracted nipple. A vacuum can be made in a bottle with a large mouth by inverting it in hot water and placing it quickly over the breast. The nipple is thus drawn into the bottle and made more prominent. Weak children, disinclined to nurse, have often to be held by the assistant (the mother has often to allow the breast to hang over a "weak nursling"), and great perseverance is necessary to make them take the requisite amount of nourishment to sustain life.

Irregularity in nursing often does infinite harm. The digestion is hindered and the mother's milk is changed in character by being irregularly secreted. When there is overfeeding the milk is often returned unchanged, or there may be vomiting or indigestion.

The nipples and the mouth of the child *must be kept clean*, otherwise both suffer, the child from its sore mouth, the mother from infection carried into the ducts, and the resulting much-dreaded abscess.

The mother should avoid diet and drinks of a stimulating character, and keep herself as far as possible in a quiescent state during the nursing

period. If the child is well nourished the weight should steadily increase, the week's average being from four to eight ounces. If losing in weight, affected by colic, sleepless, and passing food in an undigested state, the child requires the attention of the physician.

Weaning is usually begun at the ninth and completed by the twelfth month, unless the heat of summer makes the time undesirable. Dr. Rotch, of Boston, first put into practice the method of modifying cow's milk to proportions of fat, sugar, and albuminoids, found by recent analysis to be contained in mother's milk. Cow's milk contains fats four per cent. (cream), sugar four per cent. (sugar of milk), albuminoids four per cent. (casein), in round numbers, while the mother's milk of a high general average contains fats four per cent., sugar seven per cent., albuminoids two per cent. The albuminoids, as a curd-forming element, is the one most apt to cause trouble in the child's digestion.

Weaning; Artificial Food.

The best substitute we have for mother's milk, according to recent teaching, is cow's milk modified. The Walker-Gordon laboratories in different cities meet the needs of a food containing the exact required amounts of fats, etc., in a given case—that is, they supply the proportions ordered by physicians on prescription. Dr. Rotch has taught how to think in percentages of the various methods of preparing cow's milk. Among domestic methods of modifying cow's milk to the proportions of mother's milk are the following: "Top-milk" method, spoken of by Dr. Holt in his excellent handbook on *The Care and Feeding of Children*. From a quart of milk allowed to stand in a cool place for five hours remove the top third about six ounces carefully by means of a spoon, and avoid agitating; to this add two parts of water and a teaspoonful of sugar (preferably milk sugar). Barley water is advised instead of water, as it prevents the curdling of the milk in large lumps in the stomach. This proportion will keep well for two days in winter, but should be made fresh every day in summer. The milk thus modified can be given simply heated, or it can be "peptonized," "sterilized," or "Pasteurized" (the last method by means of Dr. Freeman's "Pasteurizer"), or it may be set aside for future use after simply heating the milk to 167° Fahr. and *putting it at once on ice.*

FIG. 33.—A NURSING BOTTLE.

The exclusive use of "proprietary foods" has been found to give rise to malnutrition and hæmorrhagic disease, known as scurvy.

The nursing bottle (Fig. 33) should be free from grooves in which

dirt can lodge, and should be provided with a straight black rubber nipple (those furnished with long tubes *can not* be made clean). Both the bottle and the nipple should be boiled between each feeding.

The Nursing Bottle.

"Modified" and "sterilized" milk can be had in bottles suitable for one feeding. It is best heated by standing the bottle in warm water.

GENERAL RULES FOR FEEDING INFANTS (DR. T. M. ROTCH).

AGE.	Intervals of feeding.	Number of feedings in 24 hours.	Average amount at each feeding.	Average amount in 24 hours.
First week	2 hours.	10	1 oz.	10 oz.
One to six weeks	$2\frac{1}{2}$ hours.	8	$1\frac{1}{4}$ to 2 oz.	12 to 16 oz.
Six to twelve weeks, and possibly to fifth or sixth month	3 hours.	6	3 to 4 oz.	18 to 24 oz.
At six months	3 hours.	6	6 oz.	36 oz.
At ten months	3 hours.	5	8 oz.	40 oz.

CHAPTER XIV.

NURSING INFECTIOUS AND CONTAGIOUS CASES.

IN the care and isolation of those suffering from contagious and infectious disease much depends upon the person in immediate charge of the patient. Next to the physician, on her rests the responsibility of preventing the spread of disease germs. She must first understand and believe in the contagiousness of the germs, and feel the importance of carrying out the measures established for their extinction. Waging daily warfare against these enemies of mankind is as useful, and requires almost as much courage and perseverance, as the "taking of a city."

Responsibility of the Person in Charge.

Isolation, to be complete, must include the removal of superfluous draperies, furniture, rugs, etc., the shutting off the sick-room or apartments from other parts of the house, and the destruction of the germs thrown off from the body, or means for keeping them under control. This task would be accomplished easily if the germs could be seen, but, as they are invisible, we sometimes forget them.

Isolation.

If possible, two rooms should be given up to the isolation—one in which to disinfect and make all arrangements for the care and comfort of the patient, and the other for the occupancy of the patient, or one

may be occupied while the other is airing, the exchange being made every twenty-four hours. This is an admirable plan, but entails extra labour. The rooms should be at the top of the house. If other rooms on the same floor have to be used, a sheet kept constantly wet in a mixture of glycerin, one part to six parts of carbolic-acid solution (1 to 80), should be tacked to the outer frame of the door of the sick-room, so that it sweeps to and fro when the door is opened. This tends to catch and imprison the germs, and prevents them from floating out into the surrounding atmosphere. Two sheets should be kept in constant use, one always soaking in the solution. They should be boiled, if possible, every third day.

Location and Arrangement of Rooms.

Communication with others in the house can be established by means of a slate on which the messages are written in a large hand so that they can be read at a distance. The children of the family should be sent to other households—if possible where there are no children. Other preventive measures include thorough cleanliness of all objects and utensils, destruction of all excreta, introduction of a free supply of sunlight, air, and heat, that drive out dampness and foul air. All dust should be removed daily from woodwork, furniture, and floors with a cloth dampened with bichloride, 1 to 2,000 (germicide). The floors should be wiped up on hands and knees. Avoid too much moisture, as wetting the germs down instead of removing is objectionable. They are sure to float again in the air as soon as dry. The highly polished floor is the most sanitary. Nothing should be removed from the rooms without being disinfected or protected by coverings saturated in disinfecting fluid. Even unused food should be enveloped in paper ready for burning and sent down in this way.

Further Preventive Measures.

An open fire adds greatly to the ventilation of the room, and can be readily used for destruction of unused food and excreta. Old cloth, cheese cloth, or soft Japanese paper napkins can be used for all discharges from the nose, expectoration, etc., and for washing from the surface any discharge from the bowels. *These should be burned at once.*

Value of an Open Fire.

If fæcal matter mixed with sawdust can not be burned, it should be saturated, thoroughly mixed, and allowed to stand one hour in a solution of chloride of lime, six ounces to the gallon of water. Urine can be disinfected in the same way. The water-closet can be disinfected with the same solution or with simple slaked lime in solution.

Disposal of Fæces and Urine.

Keep the room as far as possible free from flies. They and other insects have been the means of conveying infection from one person to another. The bed should be kept scrupulously clean, frequent changes of linen being made. The clothing, when not soiled, can be wrapped

tightly in a carbolized sheet and sent at once to be boiled, or it can be soaked for six hours in a solution of carbolic acid (1 to 20), and then boiled. Clothes that are soiled should be washed first by the attendant and then subjected to the carbolic solution and afterward boiled. A washtub or footbath placed on a stool can be used for the disinfectant, and a special boiler kept on the range ready for use. The water in these should be changed every twenty-four hours.

Care of the Room, Bed, and Linen.

The patient should be bathed as often as permitted. When oily substances, such as vaseline, etc., are used upon the skin in the eruptive contagions to prevent the scales from flying, they should not be allowed to accumulate, as they prevent the action of the skin and too much work is thrown upon other organs in consequence, especially upon the kidneys. To guard against chilling is of equal importance for the same reason.

Care of the Patient.

When the eyes need protection, as in measles, etc., use a screen directly over the eyes or about the bed. *Do not in any case shut out the sunlight from the room.*

Dishes and all utensils not injured by heat should be boiled frequently. A large tin pan and gas stove are indispensable for this purpose, and always before returning them to the household supply cleanse and disinfect them.

Children's toys, books, and brushes that have come closely in contact with the patient should be burned.

When convalescent and ready to leave isolation, the patient should be bathed in a solution of bichloride (1 to 5,000), the hair being washed in a solution of 1 to 1,000. The body can then be enveloped in a clean sheet and the patient taken to another room.

Instruction for disinfection of the rooms and their contents will be found in the articles on *Hygiene* and *Diseases in General.*

It remains only to mention a few points that may be helpful to the person in charge of the patient. Simplicity of dress, as few articles as possible being worn, is important. Old shoes and corsets that can be burned should be used. If good shoes be worn it is necessary at the end of the case to scrape the soles well and subject them to a thorough wetting in bichloride, which does not improve their condition. Shoes can be made noiseless for night use by a bandage of old muslin torn in four-inch strips and wound about them. Cotton clothing should be used—simple fabrics that bear boiling or carbolizing. In cold weather a sack or dressing gown of wool may be necessary. Subjecting wool goods to carbolic for one hour only does not materially injure them, or they may be baked in an oven at moderate heat for a number of hours to disinfect them.

Dress and Hygiene of the Attendant.

The hair should be covered by a triangular bandage made of soft muslin and tied about the head (see *Surgical Injuries and Surgical Diseases*, Figs. 4 and 5) *so as completely to envelop the hair.* This point is very important. The hair, being naturally moist and oily, encourages the retention and growth of bacteria, and is almost as fruitful a medium for their transmission as the "finger nail." At least four of these bandages should be provided, and if one of them be worn constantly while in the sick-room it enables the attendant to take outdoor exercise without washing the hair.

When following out these instructions one can go out with safety while in quarantine, after brushing a solution of bichloride or carbolic rapidly over the hair with the hand, taking a bichloride bath and changing the clothing. If the patient can not be left, an airing should be taken by protecting the body from cold in winter and sitting for an hour or two at an open window. This is quite as important as the necessity for taking *plenty of very nourishing food*, *gargling the throat* two or three times daily, especially in caring for diphtheria, or contagions involving sore throat, and taking *a tonic.* After the patient is out of quarantine and the disinfection of the room complete, the hair of the attendant should be well washed in bichloride (1 to 1,000), and afterward with strong soapsuds, and the body sponged in a solution of the same strength, followed by a hot bath.

CHAPTER XV.

CONVALESCENCE.

Convalescence, so tedious and irksome to the person recovering from a severe and lengthy illness, can be made both endurable and interesting. A variety of occupations of a mild and judicious nature should be planned, and watchfulness exercised that overfatigue or too much excitement does not discourage the patient or cause him to lose self-control.

"Sitting up."

When the temperature, pulse, and respiration have reached the normal limit, and the appetite, sleep, and general feelings of activity are returning, the patient may be allowed to sit up in bed supported by a back rest. The time is usually limited to from ten minutes to half an hour on the first day. Gradually the time is increased and the interval shortened. *Do not wait for the patient to complain of fatigue. On showing signs of this he should be put to bed at once.* Those who are well and strong little realize the amount of exertion and excitement caused by the simple act of sitting up.

The Nightingale.

The "nightingale," named for Miss Florence Nightingale, the pioneer nurse, who, as is well known, did such noble work in the Crimean War, and who established the present system of training nurses in hospitals, is a useful wrap to be worn about the shoulders in bed. It is usually made of eider down or some light-weight flannel, for the dimensions of which see Fig. 34. The corners of the cut made at the middle of the goods are turned back to form the opening for the neck, and the whole piece can be hemmed around with feather stitching. The outer corners at the extreme lower border can be finished with two buttons and buttonholes to gather about the wrist, and the "nightingale" can be held in place by ribbons tied at the neck in front.

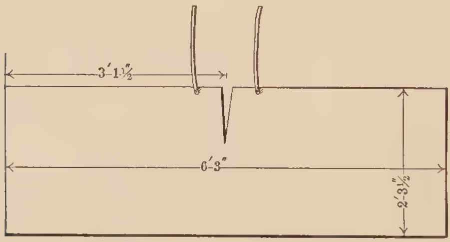


Fig. 34.—A Nightingale.

The Bed Sack.

A "bed sack" is recommended by Miss Camp in her *Reference Book for Nurses* as affording better protection for the arms. "Picture to yourself a white flannel sack with the usual shoulder seams and arm sizes, the back in one piece about twenty-four inches broad from arm to arm, the front and neck correspondingly large. The neck, left straight, and two inches higher than usual, is faced with soft blue or pink silk, shirred three or four times, and gathered up just to fit the throat and tied with ribbon to match the silk. The sleeves, made full, similarly faced and shirred, make the sack quite complete. It is so broad across the back that it is put on without the least effort, and the bit of colour about the throat makes it very attractive."

On leaving the Bed.

When the patient is able to sit out of bed a reclining chair or sofa may be used, but there is an advantage in having a wheel-chair or cot so that the patient can be wheeled or carried into another room. In many cases change of scene, if only for an hour, is very beneficial. Provide warm stockings, bed slippers, and a wrapper for protection and pillows for comfort. The foot of the chair should be placed at right angles with the bed, so that the person lifting can turn and deposit the patient without going around the chair. The pillows should be built into the seat and back and the blankets spread over them. The patient, if not too heavy, can be lifted by one person. The arms of the patient can be locked about the neck of the attendant, who, placing one hand under the thigh and the other under the back, can lift even a very weak patient without much upsetting. When two people are required in the lifting they should both stand at the same side of the

bed, placing the hands, one under the shoulders and buttocks, the other under the thighs and ankles, and, lifting in unison, turn and put the patient into the chair gently. The blankets are then turned up at the foot, folded over from either side and fastened securely by safety pins to insure keeping the feet warmly covered. If the patient suffers from cold feet a hot-water bottle can be put to the feet before pinning the blankets. The upper blanket can then be fastened about the neck and shoulders, or a nightingale may be worn (Fig. 35).

As the patient gains in strength his condition will be greatly benefited by the fresh air, and if not strong enough to bear driving he might be

Fig. 35.—A convalescent.

carried into the sunlight on a cot, and, if necessary, an umbrella used to protect the head. The first drive should be made short, increasing daily.

Diet and Exercise.

The diet of a convalescent must be watched carefully, and, if the appetite is failing, or undigested food is vomited, the condition is probably due to overeating or to food that is unsuitable. At this period some patients have to be constantly spurred on and encouraged to use their strength, while others have to be held in check. It is here that the greatest exercise of tact, discernment, and self-control on the part of the attendant are necessary. If confidence be established, and through strong personal influence complete control of

the will of the patient be gained—this is especially true in nervous affections—rapid recovery should be made.

Relapse.

Relapse, except in the germ diseases, is probably most often due to overexertion, overfeeding, or nervous excitement. The condition of nervous excitement in certain people often reaches a high pitch before it becomes visible, or before the patient gives any sign. The quick, trained eye should see this condition coming on and should, if possible, prevent it by sending away the visitor, changing the conversation, or making the patient lie down or take a walk in the fresh air.

Visitors.

In early convalescence the visits of friends have to be limited, and it is often best that the patient be kept in ignorance of their solicitude. Avoid discussion of the matter in the presence of the patient, and thus remain master of the situation. The few callers that are permitted should come at a time when the patient is at the best and their stay should be brief. Preparation for the night should be made early. A sponge bath, gentle rubbing to take the place of exercise, will often insure a good night's sleep.

CHAPTER XVI.

CARE OF THE DYING AND LAYING OUT THE DEAD.

Disease terminates either in resolution and a return to health or in the alternative, death. When death takes place and there is no physician present, the fact must be established. (See *Surgical Injuries and Surgical Diseases*, Chapter XIII.) It is thought by those who have investigated the subject that death is much less painful than is popularly supposed, and long hospital experience justifies this belief.

Care of the Dying.

There is very little that can be done for the comfort of the dying. Unless unconscious, they naturally take the position that gives greatest ease, and usually they should be allowed to remain in that position except when extreme dyspnœa exists. The perspiration can be removed from the surface with soft towels or handkerchiefs and the face gently fanned. An extra amount of external heat can be applied when the extremities are cold, and the action of the heart is sometimes materially increased by use of a hot poultice or a sponge wrung from hot water and applied directly over the surface. If the patient can swallow, half an ounce of brandy in hot water can be given, or an enema of whiskey, one ounce to three ounces of hot water. Great

relief also is sometimes given by the introduction of cold air from the top of a window.

After the fact of death has been established the chin may be held in place by a bandage, or supported from below by a pillow case folded into small compass. The eyelids can be kept closed by placing a tiny piece of thin moist paper under the upper lid. The hair should be combed and, in case of a woman, braided firmly, and a lock of hair taken for the friends. The body should then be bathed, the orifices left open, and a large sheet folded into a triangle well padded with cotton wadding can be used to envelop the loins and receive the discharges from the bowels. Closing the orifices, or putting tight bands about the body is objectionable; the gases have then no proper means of escape. The ankles, knees, and wrists should at first be tied firmly together. It is quite unnecessary to place the head low or in the unnatural position so often seen. One or two pillows can be used.

Bathing and Arranging the Body.

If no undertaker is in immediate attendance the use of ice upon the abdomen (to prevent decomposition) is advised. A large flat pan (probably the best home arrangement that can be made) is filled with cracked ice and placed upon the abdomen over the first sheet, and the ice kept replenished as it melts.

To Prevent Decomposition.

Avoid using fluids upon the surface, as they only soften the skin.

Air should be admitted from the top of the windows, keeping the lower sashes closed. This precaution prevents the entrance of intruders from outside and creates a better circulation of the air. Direct draughts should be avoided. The room should be kept cool—as cold as possible—and if ice is plenty, two or three large pieces standing in tubs about the room would be useful.

If an examination (autopsy) is to be made, protect the carpet with old rugs or paper, provide a firm table or board on barrels, three pails and basins and pitchers of hot and cold water, ice, twine, a large needle, a roll of cotton wadding, soap, stiff nailbrushes, and bichloride solution (1–1,000).

Preparing for an Autopsy.

The clothing should be opened through its entire length at the back and carefully folded under by turning gently from one side to the other. A long nightdress should be used till the time for placing in the coffin arrives.

Arrangement of the Clothing.

In dressing for the grave a dress formerly worn gives the most natural effect, especially in the old; otherwise, cream, white, or lilac, if the casket be of the same colour, can be used. Simplicity of detail, always most elegant, is especially suited to the dignity and solemnity of death.

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THE END.

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